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AIR&SPACE

REFLECTIONS ON THE COLD WAR

Smithsonian • September 1994

The shuttle thunders onto the big screen in

DESTINY IN SPACE

Scary Skies: Russia's Airline Revolution

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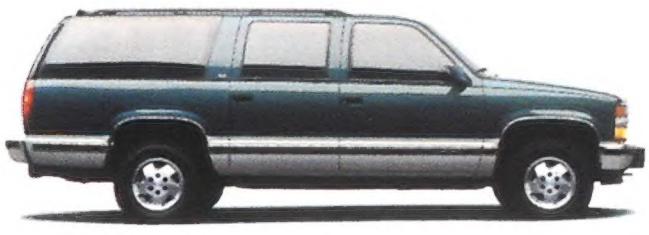
With An Interior Large Enough
We Thought We'd

The 1994 Chevy Suburban Silverado is truly one unique vehicle. It's a very big one, as well.

That's why we've made it available with dual climate controls. There's one for those who sit up



front. And one for those in back. Which is a pretty cool (or hot) option, depending on where you sit. Oh, and did we

To Have A Mason-Dixon Line Give It Two Climates.

mention that the '94 Suburban is big enough to seat nine passengers? Did we mention they'll be able to luxuriate in available custom leather seating surfaces? Or that Suburban can stow up to 149.5 cubic feet of "stuff" in its cargo space? We hope we didn't overlook anything. Then again, the '94 Suburban is pretty hard to overlook.

Chevy Suburban
LIKE A ROCK

August/September 1994
Volume 9, Number 3

AIR&SPACE

Smithsonian

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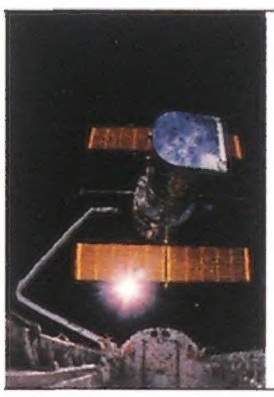

Cover:
A new IMAX movie shows the deft and daring repair of the Hubble telescope.

Departments

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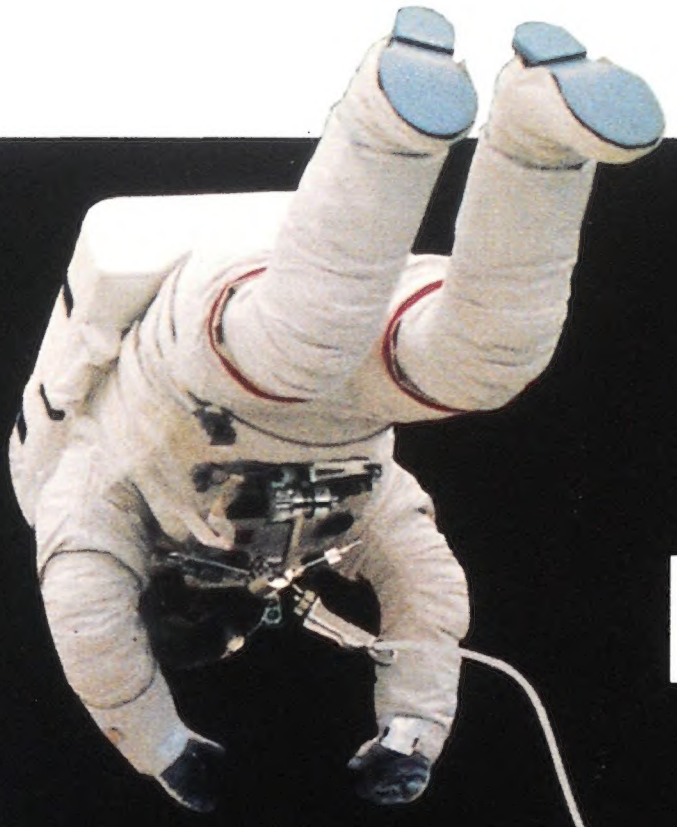
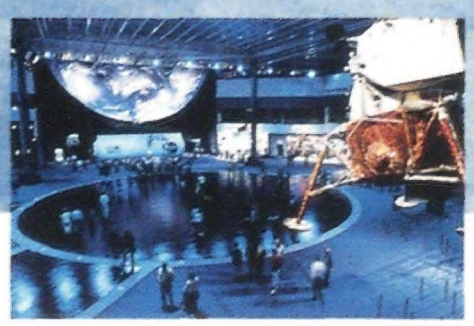


Your kids shouldn't think Luke was the only skywalker.



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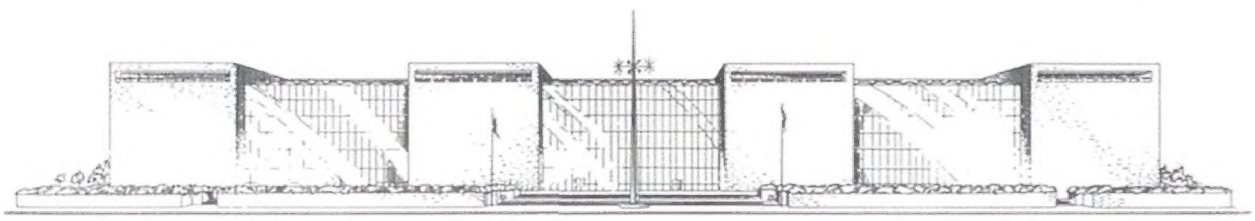

Destiny in Space

This summer the National Air and Space Museum and NASA visitor centers are premiering the film *Destiny in Space*. In the fall, it will open in large-screen theaters worldwide. It looks at the future of space exploration, and tacitly asks what we mean by "going there."

Robotic spacecraft, like Viking, which visited Mars in the late 1970s, provided such a wealth of data that the computers of the day could not fully cope. Fifteen years later, computer techniques have so advanced that the same data have been used to give viewers of *Destiny in Space* the opportunity to fly over the Martian landscape with an airplane pilot's panoramic view. Similarly, data on Venus obtained in the last few years with the Magellan spacecraft's radar system provide a computerized overflight of the Venusian surface with the clarity obtained from the window seat of an aircraft flying over the western United States—only the topographical features are quite different.

The next-generation spacecraft will provide even more detailed images of the planets. The recent Clementine mission gave us a foretaste by imaging areas of the moon never before seen as clearly. And robotic spacecraft that combine the analytic capabilities of the 1976 Viking landers on Mars with the mobility of the 1970s Soviet Lunakhod rovers, which roamed the surface of the moon, would enable us to scoop up soil anywhere we wished and analyze it, mineralogically and chemically, without ever requiring humans to leave Earth.

Given that robotic spacecraft can do so much, making us virtually feel we are there, is there any way that human space travel could do even more?

Destiny in Space tells us that to answer this question we will need to know more about how humans cope on long journeys. For shorter stays in space, Skylab, Mir, and the shuttle have already taught us a great deal and have shown that humans can work wonders of ingenuity, as in repairing the Hubble Space Telescope.

But we know no way of simulating the effects on the human body and psyche of a three-year journey to Mars without actually having astronauts spend that number of years in a near-Earth space station where they can be kept under surveillance and, if necessary, be quickly returned to Earth.

The effects of weightlessness, exposure to cosmic radiation, and enclosure in a small capsule with a handful of other people for years at a time all need to be understood before humans can undertake extended journeys. We will also need to advance closed-cycle farming techniques to provide spacefarers affordable sustenance. And recycling air, perhaps as a side product of space agriculture, also will need to be refined.

Such research and development efforts are costly. They make sense only if we are determined that people embark on long space voyages. Given that many of the purposes for which humans might journey can be served by deploying robotic scouts, what are the special needs for human travel?

A compelling reason for men and women to leave our planet might be to colonize other worlds or to build new habitats in space—possibly giant space cities dreamed of in science fiction. But we have never had a serious public discussion for or against an undertaking on such a scale. And that may be the reason why funding a space station is so difficult to justify to Congress today. Yet it is just such a station that would be needed in order to define the basic elements required for extended living in space.

If *Destiny in Space* can help us understand the sequence of steps we will need to follow in the exploration of space, and the alternatives that we may need to consider as we test our way, the film will have served its purpose.

We hope *Destiny in Space* will be of interest to readers of *Air & Space/Smithsonian*, as well as to their children—our future explorers of space. (For more about the film, see p. 50.)

—Martin Harwit is the director of the National Air and Space Museum.

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LETTERS

B Is for Balance

Reading the excellent article "What Makes It Wright?" (June/July 1994), I found myself growing irritated at Charles Dempsey's condescending attitude toward the Wrights' considerable intelligence and skills, as exemplified by his comment that they were "better photographers than they were engineers." It's easy to denigrate the Wrights' work when you've never invented an airplane from scratch yourself.

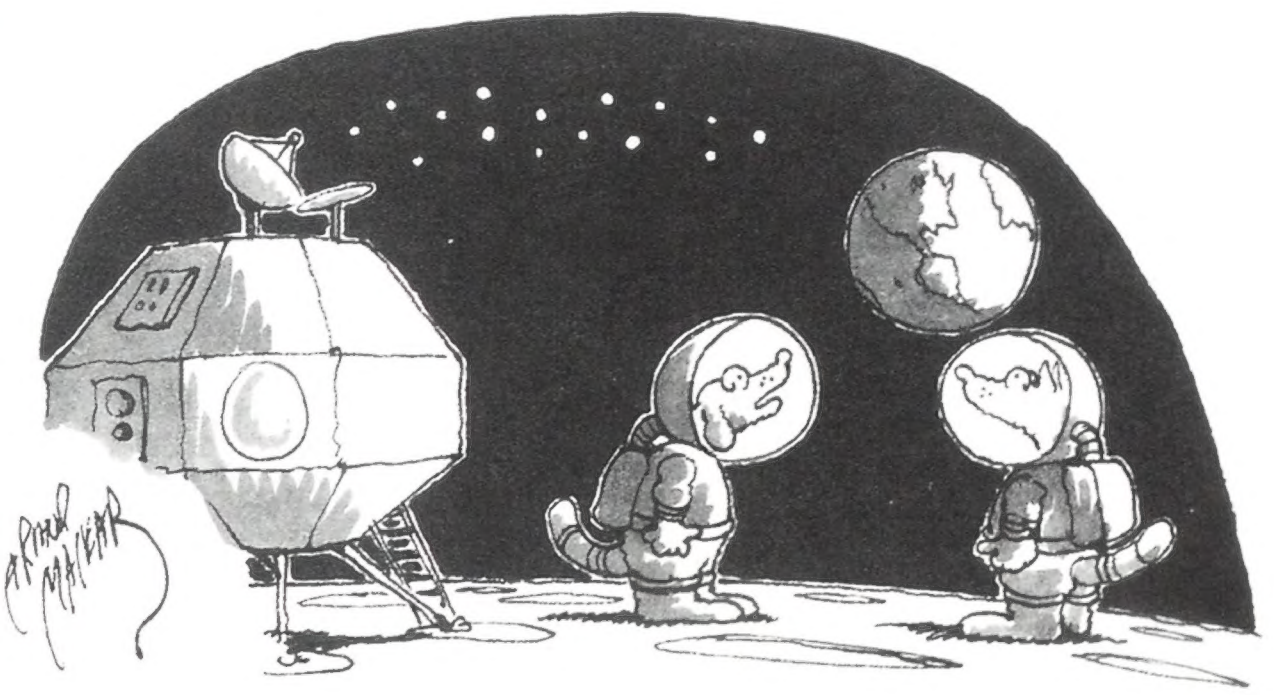
Dempsey refers to a photograph of a Wright machine with its nose high in the air and says, "That airplane is not in balance. That airplane will not take off." While conducting research for my upcoming book *American Icarus*, a history of human flight up to 1919, I reviewed numerous photographs of Wright flying machines, and my hunch is that the photo Dempsey refers to does not show a Model B at all but rather a special Wright Model R known as the *Baby Grand*. Like Dempsey's modern-day machine, to the untrained eye it resembles a Model B, but the *Baby Grand* had a much shorter wingspan and a heavier, more powerful aft-mounted engine. In every photo I've seen of the *Baby Grand* without a pilot, its nose is higher than a two-time prom queen's, but with a pilot aboard, the craft rests nice and level on its skids. Furthermore, in all the photographs I have seen of a Model B, with or without a pilot, the craft is level on its skids. Perhaps Dempsey should be sentenced to multiple re-readings of the two-volume *Papers of Wilbur and Orville Wright* before being allowed to publicly expound on their work again.

—Phil Scott
New York, New York

Marauder Memories

In "Did He Say Five Hundred Feet?" (June/July 1994), Daniel Ford states that both B-17s and B-24s attacked Omaha Beach. However, Omaha was the target of the Second Air Division, made up of B-24s. The B-17s of the First and Third Divisions were assigned other targets.

Ford also states: "These high-altitude precision machines [B-17s and B-24s] never saw the defenses they were supposed to destroy." I was a First Division pathfinder navigator, leading 18



"Let's go back! I think I hear a can opener!"

"This is the captain. When we reach cruising altitude feel free to move about the cabin."

airplanes of the 381st Bomb Group in an attack on Gold Beach, north of Bayeux, and in my case Ford's assertion is true. But some visual attacks were made. Ford should ask pathfinder navigator Clem Obler or bombardier Henry Matty if they saw the target they were ordered to attack.

Finally, having written a manuscript on D-Day, I, like Ford, used the book *Invasion—They're Coming!* as a reference. But my copy says that the author is Paul Carrell, not Paul Karl Schmidt.

—Captain John W. Howland
U.S. Air Force (ret.)
Carthage, Texas

Daniel Ford's article was in general very good. However, it had some inaccuracies. (1) The enlisted men did not get cursory briefings. They were briefed on the part of the mission for which they had responsibility. (2) Most of the bombardiers could wear their parachutes in the bomber's nose. It was a tight fit to get through the crawl space and past the copilot's seat, but they did it regularly. (3) The four fixed guns mounted on the side of the fuselage did not come off, although they were seldom fired. (4) The commander of the 386th Bombardment Group was Colonel Joe (not Joseph) W. Kelly.

The exact number of aircraft, mission altitudes, and mission results will never be determined. In 1988, while editing *The Story of the Crusaders*, which recounts the history of the 386th, I secured a copy of the now-declassified IX Bomber Command summary for the June 6, 1944 morning missions. It states that 423 Marauders took off, 330 bombed primaries, 64 were recalled due to weather, 28 failed to bomb, 28 received battle damage, three were lost over enemy territory, and two crashed in England.

The summary also lists the bombing altitude of each of the groups, and the lowest visual bombing reported was by the 386th at 3,500 feet.

—Lt. Col. Barnett B. ("Skip") Young
U.S. Air Force (ret.)
Fort Myers, Illinois

Daniel Ford replies: Captain Howland is right that there were only B-24s at Omaha Beach. However, the B-17s at Gold also bombed from 15,000 feet, through the clouds, and without destroying the shore defenses. (Colonel Obler was 20 miles inland.) As for Paul Karl Schmidt, his name was Anglicized with his book, probably to help it sell.

My numbers differ from Colonel Young's (and those in most history books) because I counted just the airplanes targeted on Utah

REUNION ALERT

SAM FOX Reunion. Open to civilian and military supporters of the 89th Airlift Wing and earlier Special Air Mission units, notably the 1254th Air Transport Wing. October 6–8, 1994, Andrews AFB, Maryland. Contact Kip Coppage, (301) 981-5800, or Everett DeWolfe, (301) 981-2855 or -6355.

LETTERS

Beach, not those assigned to shore batteries on the east or west. I gladly yield to him on Joe Kelly's name and the matter of the bombardier parachutes, but none of the photos in his splendid book shows Marauders carrying "packet guns" on European missions.

Give the Unions Their Due

Robert Crandall's essay "The Survival Equation" (June/July 1994) is just another example of crybaby management. Crandall should consider the fact that the only consistently profitable airline of late, Southwest, is one of the most heavily unionized airlines in the world. I wonder how many vice presidents, directors, managers, coordinators, etc., Crandall has working for him, and how many there are at Southwest.

I work for an airline that is having a lot of problems caused by overmanagement. Before it was involved in a merger several years ago, it had minimal management, and everyone was responsible for his own work. Now we have so many managers there's not enough office space for them all. Nobody is responsible because there are so many places to pass things off to, and everything has to go through so many channels that nothing gets done.

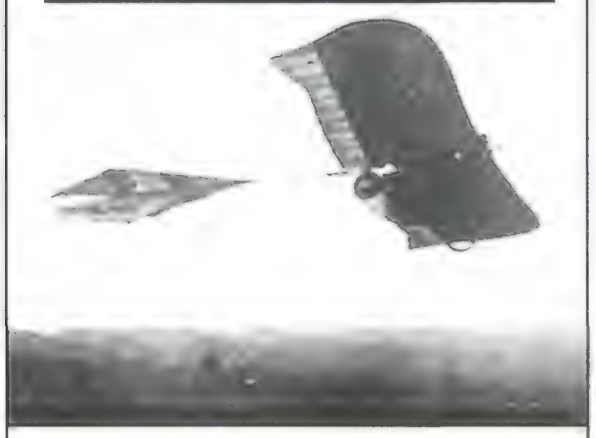
People like Robert Crandall are quick to pat themselves on the back and give themselves all kinds of bonuses when times are good, and just as fast to blame the dreaded unions when times get tough.

—John J. Crifasi
Staten Island, New York

You Can Follow But You Can't Lead

The 777 is not the first aircraft to be totally designed by computer, as Boeing claims in "You Can Look But You Can't Touch" (Apr./May 1994). The Airbus

UNIDENTIFIED FLYING OBJECT



Can you identify this aircraft? From time to time the National Air and Space Museum receives photographs of objects that its archivists cannot identify. The staff believes this aircraft, which dates back to around 1909 to 1912, was photographed flying in France or possibly England. It is not an Antoinette. If you can solve the mystery, write to: Letters, Air & Space/Smithsonian, *901 D St. SW, 10th Floor, Washington, DC 20024; via America Online:* airspacedt. *Please type or print clearly, and include your daytime phone number. The archivists would especially appreciate photocopies of supporting evidence.*

A340 is. It has been in airline service for more than a year. And Airbus Industrie also uses CATIA (Computer Aided Three Dimensional Interactive Application).

—Sandy Smith
Communications Manager
Airbus Industrie of North America
Herndon, Virginia

Corrections

Apr./May 1994 "A New Life for an Old Carrier" (Collections): The first U.S. carrier to get steam catapults was the *Hancock*, not the *Intrepid*.

"Aircraft of the Skunk Works" graphic supplement: In the description of the D-21 drone, the designation "M-21" refers to the drone's carrier aircraft.

June/July 1994 "Mr. Marseille" (Above & Beyond): Shortwave transmissions bounce off the ionosphere, not the stratosphere.

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Thinking It Through

David Tumey banks the flight simulator left, then right, on command. The task may be routine, but his method of performing it is decidedly not. He has no rudder pedals to press, no stick to control, no knobs to twist or switches to toggle. The simulator's instruments are nothing but an attitude indicator and two small, pulsing white lamps. Tumey is controlling the simulator with his mind.

At Wright Patterson Air Force Base near Dayton, Ohio, Tumey and a group of researchers are creating the first generation of "brain-activated" cockpit controls—technology that converts thoughts into actions without the usual intermediaries of arms, legs, voices, or hands. Eventually, the device will enable pilots to check information readouts, adjust systems' performances, and perhaps even steer an aircraft just, in effect, by thinking about it.

The simulator is the first step. At random, either tip of its indicator bar will light up to tell Tumey in which direction he's to bank. On either side of the display a soft white light pulses in a steady rhythm and activates the pilot's mental "foot" on the rudder. The light pulses at 13.25 cycles per second, which calls forth a corresponding rhythm in the visual cortex at the rear of Tumey's brain. Two simple electrodes on his scalp measure the strength of his brain rhythm in response to the pulse, and the computer translates the responses into instructions to the simulator's automated controls. By suppressing his brain's response to the pulse's rhythm, Tumey banks the simulator to the right; by enhancing the response, he banks it left.

But how does one "suppress" or "enhance" a response? "No one really knows," says project physicist and molecular biochemist John Schnurer. "We've asked subjects to fill out questionnaires, and their response makes it clear that the more successfully they can control the simulator, the less able they are to explain how they do it." Tumey, who's logged more time in the simulator than anyone else, agrees: "At first you think of physical images, like pushing and pulling or opening and closing. That didn't work very well for me, and one day I just said the heck with it. Once I just let go and started to let it happen instead of trying to make it happen, I got better control. It was a very Zen experience."

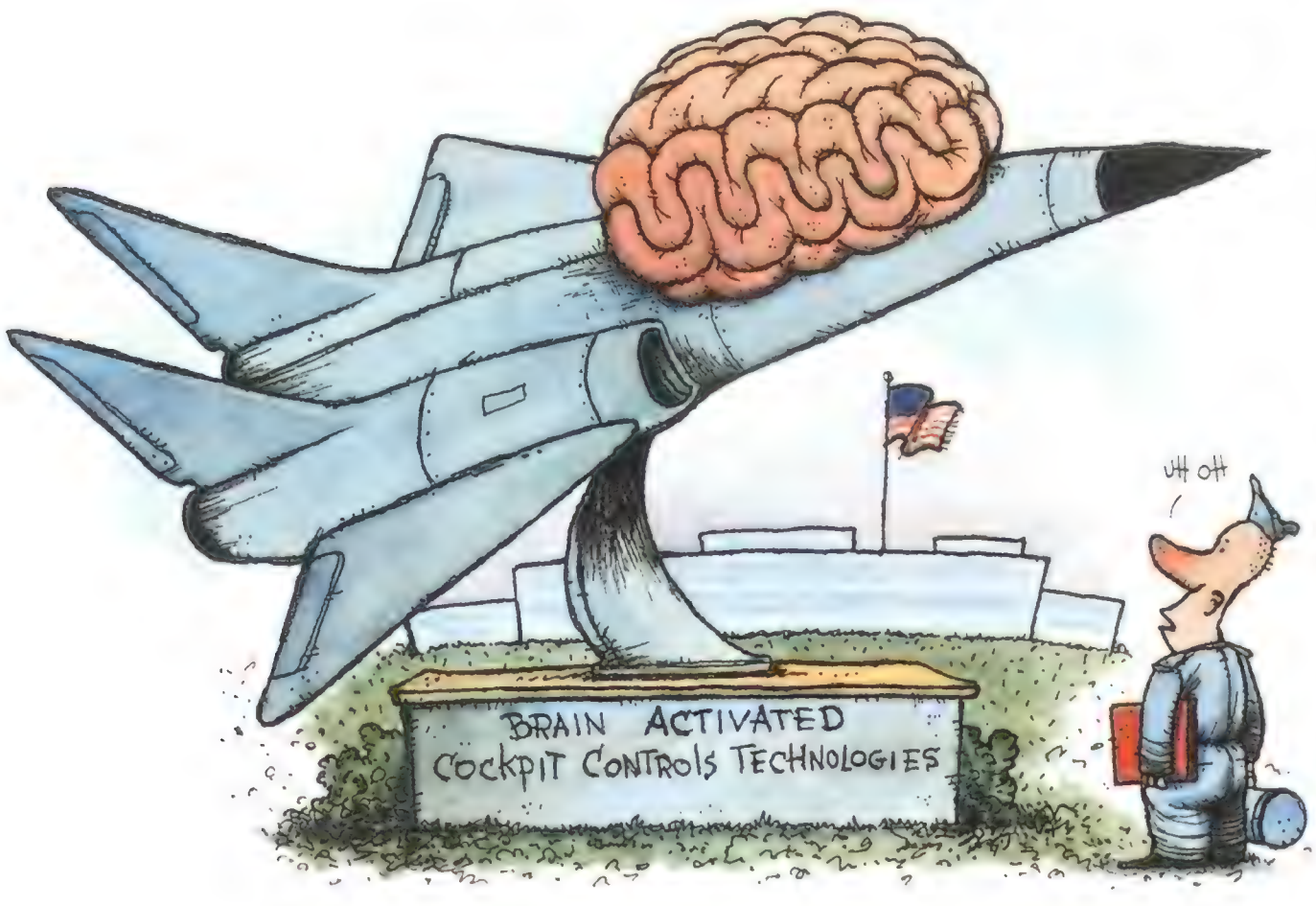
Fortunately, it's far more reliable. Engineer David Ingle says that Tumey's skill in the simulator "is such that he'd have no problem handling the control stick of a Piper Cub." Neither, apparently, would most pilots. "This isn't psychokinetic," says Schnurer. "This is a learned thing. There's no reason why 95 percent or more of the population couldn't do just as well."

The research team expects the technique to be used initially only for secondary controls. "Computerized information displays are becoming increasingly sophisticated, with so many things to be monitored that no single computer screen can display everything at once," says Victoria Nasman, the group's neurophysiologist. "If your hands are busy with other tasks, it would be nice to be able to think *I'd like to see that other screen now* or choose items from an on-screen menu."

That's only a beginning. The team is planning a variety of wide-ranging studies and also monitors similar projects in medical research, including one that has developed equipment to enable the physically disabled to control lamps, TV sets, and thermostats by glancing at icons on a computer screen. "We'll start slowly with easy tasks and optional controls, things a pilot can do if he wants but not crash and burn if he fails," says Grant McMillan, director of Wright Patterson's new biocybernetics lab. "But who knows? Twenty years from now, we might be saying, 'Gee, I'd never want a pilot to control that stick manually when he can do it so much better with his mind.' "

—Bennett Daviss

DAVID CLARK



UPDATE

Drones Resurrected

NASA's Dryden Flight Research Center in California exhumed four Lockheed D-21 drones from Davis-Monthan Air Force Base in Arizona before they were all given to museums for static display ("How the Skunk Works Works," Apr./May 1994). The space agency may eventually pair them with SR-71s for in-flight launches: last June the Senate Armed Services Committee authorized $100 million to return three of NASA's SR-71s to limited operational status.

Bizarre Bazaar

In a second-floor exhibit space in Washington, D.C.'s cavernous convention center, budding Russian entrepreneurs spread their wares for a few days last May in the new Russian spirit of "If it moves, sell it." "Technology From Russia '94," an exhibit organized by the Industrialists and Entrepreneurs Union of Russia and sponsored by the U.S. Department of Commerce, was intended to interest U.S. companies in Russian products and capabilities. "Russia's State-of-the-Art Stateside for the First Time," the exhibit brochure marveled.

In one of the dozens of aisles formed by cloth-covered tables and draped backdrops, the 1st Moscow Watch Factory set up a display of wristwatches. A few booths down, the Novosibirsk Chemical Consentrates [*sic*] Plant, Inc., showed off heating assemblies for air-cooled research nuclear reactors. In the same aisle, Dr. Pankov listed the basics of "Dr. Pankov's Method" for the "purification of the entire human circulatory system." The booths were so dissimilar that the exhibit had the jumbled feel of a high school science fair.

One booth drew more attention than its neighbors because of the big color photographs and videotape of what looked very much like a flying saucer (right). The video showed a demonstration flight of the Thermoplane, a lighter-than-air vehicle designed by the Moscow Aviation Institute. The prototype is large; the production model, which the MAI is hoping to build with a Western partner, will be huge.

"We are looking for partners because we think this is an ecological transport," said Leon Poniaev, an MAI professor turned marketing guy. "It is 22 times more efficient than a helicopter," he added, taking a swipe at the booth next door, where representatives from Mil, the famous Moscow helicopter plant, were hawking their latest: the Mil Mi-26TS. Both aircraft are answers to a question that the Russian oil industry asked: What can we use to lift heavy, bulky loads, like mining equipment, over difficult terrain in remote areas, like the oil fields of Siberia? In the 1970s, Mil designed the Mi-26. In the '80s, the MAI came up with the Thermoplane. The great advantage of the helicopter is that it's already in production. "The heavy-lift Mi-26TS is offered for lease and sale as a transport, tanker, or crane," the backdrop primly read. But whereas the Mi-26TS can lift 22 tons, a production Thermoplane, its designers say, could lift 650.

The Thermoplane's carbon-fiber envelope, made of a Kevlar lookalike the Russians call Terlon, holds spherical chambers of hydrogen or helium; the remaining volume is filled with natural gas, heated by the exhaust from turboprop engines that propel the craft.

G. Victor Lamm of Step One Technology, Inc., an Atlanta firm representing the Thermoplane in the United States and Canada, said the craft had drawn interest from U.S. aerospace firms, who were also at the conference. Lamm said the Russians were studying the ways of their American counterparts. "They *all* went to Mac World," he said, a computer show held at the convention center at the same time. One got the not altogether happy feeling that by the time "Technology From Russia '95" is put together, booths and sales pitches will be more sophisticated, replacing the innocent enthusiasm of '94 exhibitors like Igor V. Shein, whose hand-stenciled sign announced "PLASMA GUN a real breakthrough in the sphere of plasma cutting and welding of materials." Shein said that the gun, invented by Alexandre I. Apovnevitch, used "only tap water and electricity" to cut or weld any kind of metal. It could be used in the home like any appliance—"like Black & Decker," he said. He proposed a demonstration on a penny, plugged in the gun, and sure enough burned a neat, tiny hole right through Lincoln's heart.

—Linda Shiner

STEP ONE TECHNOLOGY

Cat Fight

When Damon Ise, president of the Quonset Air Museum in Rhode Island, and his salvage crew flew in the face of an Atlantic storm last December, they could not foresee the legal maelstrom that would develop around them in the next few months.

The object of their effort was a Grumman F6F-5 Hellcat resting in just 16 feet of water off the Massachusetts coast. The carcass of the World War II Navy fighter, upside down and partially buried in a shoal since it went down in April 1945 during a training flight, was discovered during a Secret Service security check prior to President Clinton's vacation in Martha's Vineyard last summer.

After the Hellcat was found, Ise told the Navy that the museum planned to recover it. The Navy advised him to wait for further advice. Worried that the aircraft might not survive much longer, Ise and his team plunged ahead. "We feel our recovery was a rescue operation," he says. "We saved a national treasure from the onslaught of the winter storms, which we thought it could not survive. In addition, irresponsible divers had already begun to strip her for souvenirs."

QUONSET AIR MUSEUM

When word of the recovery reached the Navy, Ise got a phone call from William S. Dudley, senior historian of the Naval Historical Center in Washington, D.C. Dudley said that in retrieving the Hellcat, the museum had violated federal law and might be charged with theft and destruction of government property. A few days later, workers from the Naval Investigative Service arrived at Quonset to determine whether criminal charges

should be filed against the museum, Ise, and another museum board member.

Navy spokesperson Ensign Ingrid Mueller says the Navy's position is simple: it owns the aircraft and wants it shipped to the Navy air museum in Pensacola, Florida, at Quonset's expense. Mueller read from a statement that said, "The U.S. Attorney General has filed a motion in federal court to compel the Quonset Air Museum to return possession of the aircraft to the U.S. government, which is the aircraft owner, and to pay for damage to the aircraft done by persons representing the...museum."

Ise hightailed it to Washington, hoping to strike a compromise that would allow the museum to retain the aircraft as a loan from the Navy. He was flatly refused. Backed into a corner, Ise reluctantly agreed to return the aircraft if transportation costs could be avoided and the consideration of criminal charges was dropped. Again, he was refused.

On legal counsel's advice, the museum filed a court action asserting ownership of the airplane under admiralty law, which covers the removal of hazards to navigation. Action is pending, although the Navy has approached the museum to work out a settlement.

Meanwhile, volunteers continue to work on preserving the remains of the Hellcat. "Litigation is ongoing to determine the rightful fate of the aircraft," says Ise, "but we feel this was a Rhode Island-base aircraft and it belongs here."

—*Mark W. McKellar*

UPDATE

Space Camp for MBAs

NASA's Space Camp, which initially targeted a young clientele ("I Was a Teenage Astronaut," June/July 1992), is now aiming at corporate project managers. "How to Build an Astronaut-Caliber Project Management Team," a three-day program sponsored by the International Institute for Learning in Manhattan, stresses teamwork, communication, and accountability with a simulation of a space mission and its "hazards" that teaches "principles applicable to daily business situations." According to an IIL press release, "at least one official Astronaut" will participate.

A Good Scout

When a Scout rocket blazed into the sky on a military mission last May 8, the liftoff marked the end of an era for NASA. It was the 118th and final flight for a troop of small, dependable launch vehicles dating back to 1960. Scout, an acronym for Solid Controlled Orbital Utility Test, hurled more than 90 satellites into orbit and supported the Mercury, Gemini, and Apollo manned missions (see "Get 'Em Up, Scout!" Feb./Mar. 1989).

"The Scout is an unsung hero in the world of rockets," said NASA's Bruce Buckingham, commentator for the launch from California's Vandenberg Air Force Base. The 75-foot rocket brushed the twilight sky with a brilliant blue-green contrail that was visible in Los Angeles, 170 miles southwest. Within 17 minutes the four-stage booster had delivered a $30 million Department of Defense satellite into a polar orbit, where it will conduct atmospheric research to aid in the development of sensors for ballistic missile defense.

The $13 million rocket rolled off the Loral Vought assembly line in 1986. NASA started pulling out of the unmanned rocket business in the mid-1980s, and today buys all its launch

services from subcontractors. Now Orbital Science's cheaper airplane-launched Pegasus is NASA's small booster of choice.

The last Scout looked almost identical to the first. The rocket underwent very few changes throughout its career, although its capability grew dramatically. It enjoyed a success rate of 88 percent, with only 14 failures in 34 years. Most of the duds flew early in the program: of the 95 Scouts launched since 1963, only four faltered.

"It got a little sentimental there toward the end [of the launch]," said launch director Jim Womack, who led a band of engineers from Florida's Kennedy Space Center to conduct the mission. "It was the last Scout and it was the last NASA expendable launch vehicle."

—Beth Dickey

UPDATE

Shrinksats

NASA awarded contracts for two TV-set-size Earth-observing satellites last June ("Little Launches," June/July 1993). Agency administrator Daniel Goldin says the smallsats, nicknamed Lewis and Clark, represent NASA's commitment to efficiency and profitability. The environment monitors will be completed within two years at a cost of less than $60 million each and will be launched by a Pegasus rocket rather than a Delta or Titan.

Damage Control

Originally scheduled to open last October, Denver International Airport experienced its fourth delay last May. This time it was due to a baggage system that went berserk during a test run, earning it the nickname "the baggage system from hell."

A glitch here and there in an automated baggage system can wreak havoc. In Denver's sophisticated setup, each piece of luggage is placed in its own cart, which moves on a computer-run track from arrival gate to baggage carousel. During the test, carts ran amok, jammed between railings, and failed to unload their cargo. Computers switched carts onto the wrong tracks or failed to switch them at all. Bags arrived chewed apart, and many bags failed to arrive, period. Denver mayor Wellington Webb announced a fourth delay without setting a new opening date.

Denver's Channel Nine News slipped a camera into one of the carts, which dutifully recorded the inner workings of the system as it rode the 22 miles of tracks, never to reach its destination. Several hours after cart and camera set off, a worker inched down a ladder and retrieved the camera and bags from the subterranean depths of DIA. The TV reporters found it hard to keep a straight face as they narrated the footage.

Colorado farmer Jerry Griffin volunteered to use his tractors to haul bags, an offer Webb declined. Instead, he created five committees to bring the situation under control and accepted an invitation to appear on "Good Morning America" to try to bolster the airport's image. Exhausted from years of DIA damage control and 16-hour days, Webb overslept and missed his appearance. A spokesperson in the mayor's office said, "He needed to be out the door at 4 a.m. and he didn't make it."

"The mayor of Denver was going to be with us this morning," explained the "Good Morning America" hosts, "but he got lost somewhere on the way to our cameras at the airport." Perhaps they too had seen the Channel Nine footage, because they couldn't resist adding, "We're going to have to find someone with a ladder to find the mayor." Meanwhile, the city has hired a consulting firm to diagnose the baggage system's ailments.

—John Dellinger

MARK AVINO

To commemorate the 25th anniversary of Apollo 11, neckware manufacturer Stonehenge of New York City has created the Moon Rock Collection, a series of ties based on the molecular structure of rocks retrieved during each Apollo mission. (Caution: ties are loud enough to warrant earplugs.) Stonehenge has also produced ties based on the molecular patterns of vitamins and on the artwork of Miles Davis and Grateful Dead lead guitarist Jerry Garcia.

UPDATE

GPS Goes Public

Last February Federal Aviation Administrator David Hinson announced that the Global Positioning System ("You Are Here," June/July 1992) may be used as the sole navigation source by the airlines and general aviation aircraft. Hinson also announced that the Department of Defense agreed not to scramble the signal or deactivate it without presidential approval.

The U.S. Coast Guard recently recommended that the Loran-C radio navigation system be shut down after 1996 to save money. While many general aviation aircraft owners plan to purchase a GPS receiver, some 70 percent of aircraft owners surveyed last August by the Aircraft Owners and Pilots Association still rely on Loran-C.

Swords Into Heliports

For months Lawrence Sowinski had been following the story of how Manhattan residents, weary of helicopter traffic and noise, had forced the city government to consider closing two of the city's four heliports and drastically reducing operations at the East 34th Street Heliport, the world's busiest, with 51,000 operations per year. Clearly, Manhattan, broke as it is, would soon be forced to invest perhaps hundreds of millions of dollars in a new, convenient, and modern heliport.

Recently Sowinski was paging through the *Navy Times* when he came across a list of some 70 U.S. Naval vessels due to be decommissioned and scrapped. Among them was the USS *Guadalcanal.* Commissioned in 1963, the *Guadalcanal* was one of the nation's first helicopter carriers. Having served in Vietnam and the Persian Gulf, the ship is a fully operational museum piece. The proverbial

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light bulb winked on for Sowinski.

"If you were to design the perfect Manhattan heliport," he says, "you could no longer put it on land. Ideally you'd want a multi-level floating platform with a hangar deck below serviced by aircraft elevators." The ship was already scheduled to be scrapped, "so what we would be doing is taking $401 million in taxpayer money that would otherwise be wasted and giving it a whole other career."

Fortunately, as the executive director of the Intrepid Sea-Air-Space Museum, a complex of aging warships permanently berthed in the Hudson River (see Collections, Apr./May 1994), Sowinski is in a position to get something done. He contacted neighborhood associations and the Navy about mooring the *Guadalcanal* perpendicular to the museum's pier, about 1,000 feet offshore, and all involved parties have approved the plan (the *Intrepid*'s neighborhood is sparsely populated and zoned for industrial use). "It could be two weeks, it could be two months," says Sowinski. "The Navy and the city are working to finalize the details."

The ship's 600-foot deck will handle three helicopters simultaneously, with maintenance and storage facilities for as many as 40 helicopters shoehorned into the hangar deck below. Lower-deck cabins will be converted to commuter-friendly VIP lounges and meeting rooms, all for a cost of $7 million. The *Guadalcanal* itself is free, on permanent loan from the Navy.

—*Phil Scott*

RICK CARVER

Audience Participation

"Anybody done this before?" Brian Norris asks, surveying the crowd of 12 gathered around him at the Andrews Air Force Base open house last May. Two hands go up. "Anybody else know what to expect?" Another show of hands. "Anybody here who doesn't have the slightest idea why?" A lone hand rises timidly.

Norris' audience is about to learn its responsibilities as holders of the six 25-foot poles employed by Sean D. Tucker for his triple-ribbon cut. "Remember to hit your partner on the head with the pole," Norris jokes as he demonstrates how to break down and reassemble the unwieldy poles that are paired off in three groups and pre-strung with plastic ribbon.

Tucker's supporting cast changes from show to show, drawing from the media as well as the audience. Today's group comprises some old hands, a few media types, a nattily dressed public relations director, and a bewildered passerby who lucked out, if you care to look at it that way (it's uncertain if he does). Most of them are shivering in the unseasonably cold, windy, and rainy weather, except for the PR director, who has cadged a pair of flying gloves from an F-14 pilot. They are being briefed on the run: only minutes ago the sky opened up just enough for Tucker to fly. "You'll be spaced 700 feet apart down the grass and 50 feet across," Norris says, marking pole numbers on the backs of their hands to keep order. "Keep enough back pressure on the poles so they don't bow in. We don't want to hit the airplane."

The Tucker entourage—Sean, operations chief Norris, photographer Jim Carver, and crew chief Tom Dygert—exudes a virulent enthusiasm that is highly contagious, with lots of grins, high-fives, and "Let's go!" exhortations. The group straggles past the smoky barbecue stands, the rows of PortaJohns, the booming public address speakers, and the Blue Angels' compulsively aligned F/A-18s out onto the grass between the taxiway and runway where, suddenly, all they can hear is the wind.

Norris helps each team set up their poles while Tucker, in his souped-up Pitts, whirls overhead like the Warner Brothers Tasmanian Devil. The ribbons strung between the poles hum in the wind. Plenty of pressure is needed to keep the pole steady, but the holders, distracted by Tucker's performance, find it hard to concentrate on the pole angle, particularly when he launches into the "Harrier Pass," in which he hangs the biplane on its propeller and slowly crabs across show center. "Wedge your foot against the pole," Carver advises the east-side Number Two pair. "Careful, now, not *too* much back pressure." In their enthusiasm, the pole-holders have got the pole arched like a bow.

Then Carver gives a heads-up warning, and the Pitts comes howling down the grass at 200 mph and 25 feet, like the cropduster chasing Cary Grant in *North by Northwest*. Tucker rolls to knife-edge and neatly snips Ribbon One, then arcs up and

JOSEPH HERMANN

Last June, a sampling of the canvases of Minnesota artist Charly Markert was assembled for exhibit at the Oldsmobile Balloon Classic in Danville, Illinois. Markert, who began his career painting billboards and theater backdrops, graduated to hot-air balloons in 1979 and has painted over 50 extravaganzas, from a reproduction of a 1783 Montgolfier balloon to a balloon depicting the Voyager II spacecraft and the planets it surveyed.

plummets back down toward Two and Three. The Pitts flashes by in a blur, slicing the second ribbon and sending a shudder down the poles, rolls inverted and takes out Three, then heads straight up with a kind of vertical victory roll.

"Let's go, let's go!" says Norris, herding his charges off the field so the real Harrier can lift off. "Didja have fun?"

They did indeed. Everyone splashes back to Tucker's tent for hot dogs and "International Poleholder's Union" certificates, and Norris starts rounding up pole-holders for the next day.

—Patricia Trenner

Blue Plate Special

In 1970, Bill Bettis, once a Navy flier and now the owner of the Nieuport 17 restaurant in Tustin, California, started an annual tradition that brings together the Navy's Blue Angels from today and yesterday. "We just called them up and said, 'Hey, what are you guys doing?' " says Bettis. "Their answer was 'Nothing. We go to the general's garden party [after a show] and go back to the BOQ [Bachelors Officer's Quarters] and draw straws to see who's going to McDonald's.' " According to Kevin O'Mara, who calls himself the "token Marine pilot" with the 1970 team, "Next year when we came to El Toro [to perform], the first thing on the list was to go to the Nieuport 17 for dinner."

As an aviation fanatic, no one outranks Bettis. Some of his guests last April spanned generations and talents: current Blue Angels commander Bob Stumpf, O'Mara, aviation artist and former Douglas Aircraft designer R.G. Smith, aviation photographer Harry Gann, Fighter Aces Association founder and World War II ace Jim Brooks, 1954 Thunderbird lead and author Jack Broughton (even Air Force fliers get invited), and one of the first Blues, 1946 team member Al Taddeo.

The Nieuport 17 resembles a German hunting lodge with an aviation motif. Staghorn chandeliers brighten the white linen, dark paneling, wood tables, and the collection of photos, paintings, and artifacts from 50 years of aviation history. Guests have included Curtis LeMay and Jimmy Doolittle, who first met their nemesis, German fighter ace General Adolph Galland, at the restaurant in 1980.

But it is the camaraderie and stories that attract the yearly diners. None come better armed than Taddeo. In 1946, the original Blue Angels team was delayed in getting to the Cleveland airshow. "When we got there," he reminisces, "the Army Air Corps had gone up in their P-51s and stole our show. We were furious." But, he adds, "they did it at 1,500 feet, where the general in charge said all maneuvers would stay. The next day we went up and put on a humdinger of a show and went across the runway at about 50 feet. When we got down the general really let us have it. And Butch [team leader Roy Voris] says, 'Well, General, maybe there's something wrong with my altimeter, but it said 1,500.' "

"We were serious with the airshow," says 1955-57 team member Nello Pierozzi, "but we had nothing but fun." Even accidentally. Like the time in Seattle at the 1955 Gold Cup Races: recalls Pierozzi, "We didn't know our transmissions were going out over the PA system. So we did a left echelon roll, and Zeke [team leader Cormier] says, 'How was that, Nello?' And I says, 'Like farting through silk.' " Which added measurably to the crowd's amusement that day, if little to the Blues' image.

With El Toro Marine Corps Air Station scheduled to be closed, the future of the annual dinners would seem uncertain. But not to anyone who knows Bettis' fervor for fliers and great food. Pierozzi plans to be there for the 25th reunion. No doubt he'll tell everyone that nearly 40 years after Blues stardom, a recent golf game proved his fighter pilot eye and attitude are still sharp: he shot his age, 72.

—Bob McCafferty

Enola Gay and a Nation's Memories

by Martin Harwit, Director, NASM

If the second world war was the pivotal event in the history of the 20th century, the dropping of an atomic bomb on Hiroshima on August 6, 1945, was arguably the most important single event of the war. Next spring, the National Air and Space Museum will open an exhibition entitled "The Last Act—The Atomic Bomb and the End of World War II." And as we approach this commemoration of the final chapter in the war, the Museum is grappling with some of the most profound issues it has ever encountered.

The Museum wants to ensure that the history represented in the exhibit is true to the documented facts. But 50 years may not be enough time to prepare the nation to confront such a history. How we resolve this fundamental issue will determine what we choose to remember about World War II in this exhibit and in our collective memory as a nation. George Santayana said, "Those who cannot remember the past are condemned to repeat it." It's a crisp, astute admonishment, but one that we may not fully comprehend. If we want to avoid the fate Santayana warned us about, we cannot afford to remember selectively.

For almost 10 years the Museum has been working on restoring the *Enola Gay*, the B-29 that carried out the raid on Hiroshima; it is the most ambitious project of its kind ever undertaken here. During the restoration effort, the huge bomber has been the centerpiece of the Garber facility's restoration shops, and the exhibit we are preparing now will occupy a prominent place in the Museum on the Mall. The focus of the exhibition will be the last months of the war in the Pacific and the role of the *Enola Gay* in bringing a fierce conflict to a sudden, merciful end for the millions of young American servicemen who were poised to sacrifice their lives for their country.

During the restoration effort, veterans of the Pacific war frequently asked us to put the airplane on display as soon as it was feasible. The question was: Where? Waiting to exhibit the *Enola Gay* at its proposed permanent site at the planned Dulles airport extension in Virginia would have meant a lapse of several years, and life passes by us so fast that unless we act quickly to preserve history, we risk losing it forever.

CHAD SLATTERY

This fuselage section of the Enola Gay, *shown here at the Garber facility, will be the centerpiece of a new exhibition.*

The U.S. Congress acknowledged the need to learn from history even as history was being made when it established the National Air and Space Museum in 1966, superseding the National Air Museum. Acting less than 10 years after Sputnik 1 had flown, the Congress legislated that the Museum would "provide educational material for the historical study of aviation and space flight." In that instance, the Congress sensed the historic proportions of the enterprise and acted before the record of the pioneering space efforts was lost in the rush into space.

In launching the exhibition featuring the *Enola Gay*, the Museum is keenly aware of the passage of time. The aircraft became part of the Smithsonian collection on July 3, 1949, when Colonel Paul Tibbets flew it to Park Ridge, Illinois, and the Air Force officially transferred it to the Smithsonian. In 1952, the Air Force needed Park Ridge for Korean war mobilization, so the airplane was moved to Pyote Air Force Base, Texas, for a brief period, then on to Andrews Air Force Base near Washington, D.C., where it was kept outdoors for seven years. It was vandalized, and over time, it deteriorated. The Smithsonian's curator for aviation at the time was the legendary Paul Garber, who personally gathered over half the aircraft in the Museum's collection, including the Wright *Flyer* and the *Spirit of St. Louis*. Knowing Paul, I am sure he must have fought hard to have the *Enola Gay* placed under cover in a hangar. But hangar space is always at a premium; the Air Force probably felt it had more important things to store than a museum piece, and the Smithsonian had no airfield of its own for storing the big bomber.

Had there been public interest in the *Enola Gay* at the time, the airplane might have gotten better housing. But in the

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1950s the men and women who had come back from the war wanted to return to peaceful lives, raise families, and forget about combat. Public interest in an old B-29 was minimal, and the Smithsonian had to act without outside help. By 1960 the condition of the *Enola Gay* was so alarming that the Museum staff saw no alternative but to take the aircraft apart and transport it to our storage facility, where further deterioration and vandalism could be prevented.

Still, the damage had been done, and restoring the *Enola Gay* to pristine condition has been an arduous process. By the time the job is completed, taking the aircraft apart and putting it back together with every assembly cleaned and preserved will have required around 25 worker years and will have cost the Museum $1 million.

With a 140-foot wing span, the *Enola Gay* is too large to fit into the Museum on the Mall. But even if it could fit inside, it is so massive it would break through the floor. Ultimately, when we complete construction of the Museum's extension at Dulles airport, we intend to display the aircraft completely assembled. But that will not be for several years, and in the meantime the story of the *Enola Gay* must be told. To do that, we will bring the airplane's 60-foot forward fuselage into the Museum, enough so that visitors get a sense of its size.

Everyone acknowledges that the *Enola Gay* is an important artifact because it was the airplane that dropped the bomb on Hiroshima. But the bombing of Hiroshima was not an isolated event; it was part of a complex war. The exhibition we are planning will describe the Japanese invasion of China in the late 1930s; the atrocities perpetrated at Nanking; the attack on Pearl Harbor; the ferocious fighting in the Pacific; the escalating bombing of cities, first by the Axis powers and later by the Allies; the massive destruction of Japanese cities by incendiaries; the Manhattan Project; the design and construction of the Boeing B-29 bomber and its special *Silverplate* version, modified to carry the atomic bomb; President Truman's distrust of Stalin and ambivalence about the desirability of the Soviets' entry into the Pacific war; the decision to drop the atomic bomb; the mission of the *Enola Gay* and *Bockscar* of the 509th Composite Bomb Group under the command of Colonel Tibbets; the destruction on the ground at Hiroshima and Nagasaki; and finally, the post-war evolution of atomic weaponry, which increased the destructive power available worldwide by a factor of a million beyond that experienced by the two Japanese cities.

From the outset, we wanted to tell the story with the utmost care, supporting every fact with documentation drawn from official wartime sources. Letters have poured in from all sides on how the aircraft should or should not be displayed. Most urge that it be exhibited with patriotism and pride. But a significant minority strenuously objects to any display whatever, arguing that dropping the bomb was a terrible act and that any exhibit would celebrate it. The passions of 50 years ago are one of the lessons of the war and part of its history. When we look back, we can see the deep impressions carved by those feelings, and we must come to understand them with the wisdom that only time can provide.

We can see the deep impressions carved by the passions of 50 years ago, and we must come to understand them with the wisdom that only time can provide.

Establishing the history of the atomic bomb and the end of the war has required vigilance on our part in seeking out the most reliable archival documents. We have also obtained memorabilia from veterans and have recorded video interviews with more than half a dozen crew members who participated in the Hiroshima and Nagasaki raids in order to capture the true tenor of the times. In keeping with our practice in every major exhibition, we submitted a first draft of our label script for the exhibition to the scrutiny of a distinguished advisory committee. We asked the members to ensure that we had not overlooked important facts or misrepresented events, and most important, that we had not been biased in our selection of material.

The advisory committee included Richard Rhodes, Pulitzer Prize-winning author of *The Making of the Atomic Bomb*; Edwin Bearss, chief historian of the National Park Service, a decorated veteran of the war in the Pacific, and organizer of the Pearl Harbor Commemoration in 1991; Barton Bernstein of Stanford University's history department, an authority on U.S. nuclear policy during and immediately after World War II; Victor Bond, a physician from Brookhaven National Laboratory with long experience in studying radiation effects; Stanley Goldberg, a leading scholar of the history of the Manhattan Project; Akira Iriye, a professor at Harvard University and an expert on Japanese-American relations; Edward Linenthal of the University of Wisconsin at Oshkosh, who has studied American attitudes toward war memorials; Richard Hallion, the Air Force Historian; and Martin Sherwin, director of the John Sloane Dickey Center at Dartmouth College. This group offered us valuable comments and excellent advice that helped us to strengthen and balance the first draft, eliminate ambiguity, and generally streamline the script.

Some weeks before the first draft was ready to send to the advisory committee, we invited the executive director of the Air Force Association (a non-profit organization for current and former members of the U.S. Air Force) to the Museum to let him know about the anticipated exhibition and to seek his advice. At his request, he brought along his colleague, the editor in chief of the association's *Air Force* magazine. Over lunch, they asked us for an opportunity to see the draft script so they could comment on it. We were happy to comply, anticipating that the advice of the association would be informed and useful. For reasons that remain unclear, the association never sent us their comments; instead, they chose to publish a critique of the exhibition in *Air Force* magazine.

We had accepted the Air Force Association's offer precisely because we thought their advice and criticism would help us improve on our first draft; in fact, some of the points the magazine raised were quite useful. But the article has so alarmed some veterans who read it that many have written to express their outrage.

The *Air Force* article took the script to task on two counts: first, it argued that certain aspects of the atomic bombings should *not* be displayed. In particular, the article expressed dismay that the exhibition would show images of the devastation at Hiroshima and Nagasaki, implying that showing the scale of destruction would be tantamount to an accusation against the United States, would dishonor our servicemen who had fought so bravely in the Pacific, and would constitute a tacit apology to Japan.

The Museum understands the sensitivity to those images and the ways they can be interpreted. But it is precisely

the horrendous destruction wielded by the atomic bomb that so decisively determined the outcome of the war. What else could have motivated the Japanese to end the war so suddenly? Take away the destruction of Hiroshima and there is little left to distinguish the mission of the *Enola Gay*.

A second point raised in the *Air Force* article concerned some long-cherished beliefs held by many veterans of the Pacific campaign, beliefs that in some instances have been contradicted by documentary evidence. Where there are discrepancies—in estimates of the number of casualties that would have resulted from an invasion of Japan, for example, or whether the atomic bomb should have been used as a negotiating chip in tough bargaining with the Soviets—the Museum has sought to include both the widely held views and the facts supported by documents. *Air Force* magazine objects to such practices, labeling them "political correctness," implicitly disloyal to veterans.

Those who fought in the Pacific war have a strong sense that the *Enola Gay* belongs to them. For those who would have been called upon to invade Japan and bring an end to the war, the airplane came to symbolize the way American technology saved lives. To generations who followed, though, the bombing of Hiroshima represents both the end of the war and the beginning of the atomic age. They see the airplane through a very different lens, and to them, the *Enola Gay* symbolizes far more complex issues. The commemoration the Museum has planned is designed largely for the benefit of those generations of Americans too young to remember how the war ended. It is they who will have the most to gain from the lessons to be learned.

The honor and bravery of our servicemen, their willingness to offer their lives in the fight against a ferocious aggressor, the heartbreak suffered by families who lost fathers, sons, and brothers, the strength of the nation's leadership in successfully fighting and concluding a war the United States had not sought, and the justice of the cause for which we were fighting—*all will be featured in our exhibition*. I emphasize the point only because so many doubts have been voiced.

With passions running so high, the worrisome question is whether we will succeed in providing a historically accurate account of the atomic bombings and the end of the war. If we cannot mount a thoroughly documented exhibition, then we have little hope of learning from these epochal events. And if we are unable to draw wisdom from the war's conclusion, we will have marked its anniversary with a deplorable failure.

Up in Smoke

On a cold, dreary afternoon in the winter of 1951, a test engineer stuck his head in the door at General Electric's Aircraft and Ordnance Systems Laboratory in Schenectady, New York, and called out, "Hey, I just heard downstairs that there's been a missile shot that put a chunk of metal into deep space!" We young engineers gathered around him to press for details, but he had none—just that a senior engineer had been on the phone to the West Coast, and someone there had told him. We were never able to confirm the rumor.

Back then, the thought of escaping Earth's gravity and exploring space was in the back of every engineer's mind as we developed rocket engines, airframes, guidance systems, autopilots, and all the other complex equipment for what were to us the more mundane ballistic missile programs. Everyone wanted to be on the program that would go exploring, whenever it began. But that plum fell to other engineers at other sites, and we pressed ahead with our ballistic missile development.

By 1956, the Vanguard program was well under way. Vanguard was a three-stage vehicle designed to launch a 22-pound satellite into orbit. Its developers struggled with the task of modifying existing components and testing two liquid-fuel stages and a solid-fuel spin-stabilized third stage, then getting them and their guidance systems to work in perfect harmony.

In early October 1957 the Soviet Union announced that Sputnik had ridden into orbit atop a launch vehicle derived from a powerful intercontinental ballistic missile. Upstaged, the U.S. rushed to ready Vanguard for launch at Cape Canaveral. On December 6, 1957, as we eagerly watched on TV, Vanguard barely rose above the launch stand before sliding back down, breaking up, and disintegrating into an enormous ball of fire. Vanguard's first catch-up attempt was a spectacular, embarrassing failure. It was a scenario that would, unfortunately, become all too familiar.

Meanwhile, using as many off-the-shelf components as possible, the Army's Redstone Arsenal in Huntsville, Alabama, had designed the Jupiter C vehicle to conduct experimental launches with ablative materials for reentry vehicles. The expectation was that the material would "ablate"—melt—and dissipate the frictional heat generated as the nose cone reentered the increasingly dense atmosphere. The experiments were successful, and Jupiter C was offered as a satellite launcher. At the end of January 1958, the first of these launchers, renamed Juno, put Explorer I, our first satellite, in orbit.

Public interest in the space race was high. CBS constructed a documentary around an upcoming launch of a more advanced Juno II. Walter Cronkite and a camera crew followed the manufacture of the vehicle for the upcoming launch. They filmed the assembly of the airframe, as

well as the manufacture of the rocket engine and its spectacular static testing. The components were followed all the way to final assembly at the Cape Canaveral Missile Test Annex in Florida, and the final Juno II vehicle was filmed as it was erected on the pad. Then came launch day, July 16, 1959. The film would be spectacular indeed.

The Redstone blockhouse and the launch pad from which the Juno would be launched were just north of Complex 25, where the Navy contractor team was conducting the early developmental flights of the Polaris missile. As usual, we in the Polaris hangar were monitoring the countdown over the range safety radio channel as we went about our work. Besides not wanting to miss the sight of a missile lifting into the blue Florida sky on a tail of fire, we had learned that it was prudent to keep tabs on what was happening. The remains of two earlier Polaris test launch failures, for example, had scattered to the west, toward mainland Florida, rather than down-range, and another Polaris would soon inadvertently perform the first ballistic missile outside (or was it inside?) loop.

The Juno II countdown proceeded smoothly. One of the technicians stopped by to tell us they were at 15 minutes and counting. My office mate, our secretaries, and I joined other Polaris, Lockheed, and Westinghouse engineers and technicians who were gathering outside the Polaris hangar, where we had a clear view of the Juno II on its launch pad across the road. We could hear the range safety channel on a speaker just inside the hangar. Two sailors assigned to the Polaris program took their truck down the road to the west and joined two security men at a roadblock directly behind the launch pad. A car stopped there to discharge a newspaper photographer, who set up his big Speed Graphic plate camera with its foot-long lens on a sturdy tripod.

The countdown reached zero, the first stage motor fired, someone shouted "There she goes!" and the Juno began to lift slowly from the pad. It had hardly risen when the nose began to tip slightly toward the sea, then described an arc that took it toward the south to point first at us in the Polaris complex and then to the west, toward the mainland. The missile began to pitch over as it slowly rose until it was almost horizontal, hardly higher than its full length, and gathering speed. Range safety activated the destruct mechanism, and the mid-body of the airframe, which housed liquid oxygen and fuel tanks, exploded into a roaring fireball that seemed to be heading directly toward the front of the blockhouse.

Someone in the crowd at the hangar shouted, "Look out, here comes the shrapnel!" Suddenly, we were all inside the hangar with the doors closed, with little memory of how we got there. Through the windows we could see a raging fire, but not the Redstone blockhouse. The conversation on the range safety channel was about shutting off the line that brought fresh air into the blockhouse from about a hundred yards away. There was a shocked murmur among the spectators. As far as we could tell, the Juno had gone straight into the front of the blockhouse, which was now totally engulfed in flames fed by thousands of gallons of fuel and liquid oxygen. We were gravely worried for the safety of the blockhouse crew.

Later, the sailors described the scene at the roadblock. The photographer had turned from his camera toward the guards and sailors with a huge grin. He had gotten a picture that he knew would be on the front page of every paper the next morning. Then he saw that the guards and the sailors were under their trucks, and began to realize what his picture would really show. He had looked right down the nose of the missile as it was ringed by the fireball and heading straight for him. Slowly his smile faded and his face went slack. His knees began to shake, and slowly he sank down to the sandy ground. His legs were still unsteady when the car came to collect him and his equipment.

Fire trucks arrived, and the firemen may even have helped beat down the worst of the flames. But Cape Canaveral old-timers assured us that the crew's biggest concern was to find each of the solid-fuel motors and make sure that nothing could ignite them and cause them to careen wildly around the cape, endangering life and property and starting fires in the palmetto scrub.

As the flames died down, we could see that the fireball and debris had landed to the side of the blockhouse, perhaps 200 yards toward us and directly in our line of sight. The blockhouse was unscarred after all. The range safety chatter indicated that all danger was now over. The crowd broke up and we drifted back to our preparations for the next Polaris launch.

The next morning, a secretary who breakfasted in a small Cocoa Beach cafe said, "You know, this morning the waitress told me she had a really strange customer yesterday. She said, 'There was a feller come in here yesterday afternoon and sat right here at this table. His face was as white as that tablecloth. He ordered coffee, and when I brung it he spilled more than he drunk, he shook so. I asked him, Mister, are you sick? Are you sick? and all he'd say was, I was in the blockhouse!' "

We all knew which blockhouse.

—James V. Shannon

Streaking Through Cyberspace

At the University of Manitoba in Winnipeg, Will Christie flicks on the TV and gets caught up in a movie about aerial combat in World War II. The footage is black and white, and Christie finds himself wondering about the streaks of light that lance from earth to sky and airplane to airplane. What color are tracer bullets, anyway?

Young Christie does what comes naturally to his generation: he turns to his personal computer, dials up the campus computer, and posts his query on the Internet, an electronic spider web connecting 15,000 universities, government agencies, and private firms. Of the thousands of electronic bulletin boards available to users, where learned and sometimes ludicrous conversations are held, Christie sends his question to "rec.military.aviation," which runs the gamut of subjects from the origin of bubble canopies to what happens to a ball-turret gunner in a crash landing.

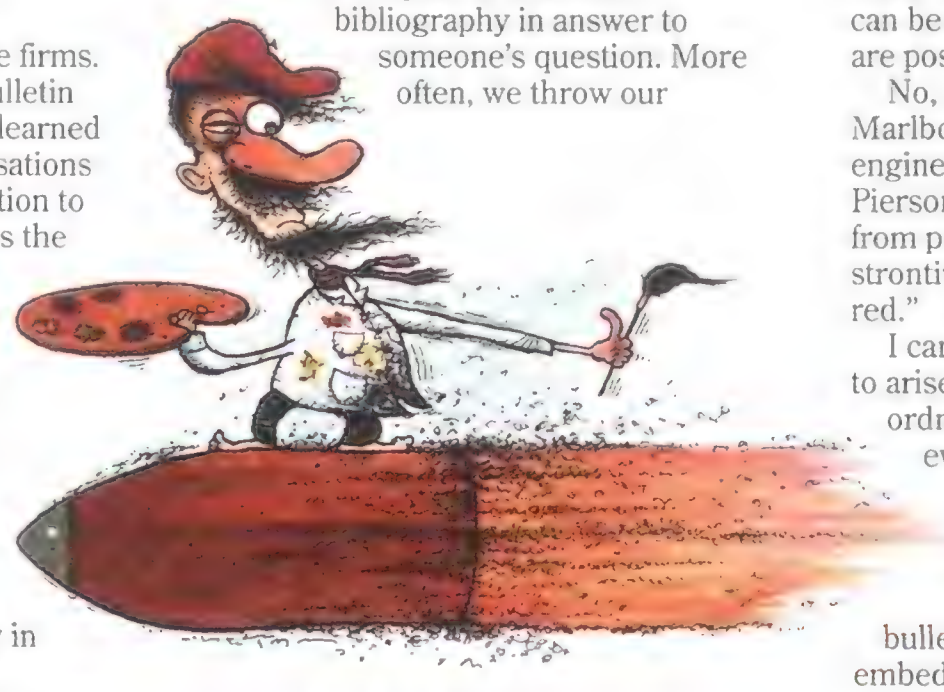
The first reply comes from Scandinavia, where computer buffs are waking up as those in Winnipeg are going to bed.

"While doing my military service," recalls Asad Rustum at the Royal Institute of Technology in Stockholm, "the only color I encountered was yellow/white. However, in Lebanon several years ago I saw also red tracers, mostly from anti-aircraft fire."

From Finland, Panu Kolju adds that he has been reading a book about his country's most famous ace, Joppe Karhunen, who flew a rotund Brewster Buffalo fighter in 1939 and dodged bullets fired by border-crossing Soviet pilots. The machine gun bursts were marked by tracers that were either red, white, or green.

Green? That's news to me, reading these notes next morning. It is noon in Scandinavia and the crack of dawn in Manitoba. Harking back to my research on the Flying Tigers in China and Burma in 1941-'42, I compose a note of my own: in combat reports the Americans spoke of their own tracers as red and those of their opponents as yellow. I hit the return key and my contribution is fired—faster than a speeding bullet—to a computer at the University of New Hampshire, which will post it to the military "newsgroup" we've been reading. Twenty million people can read my observation, though only a few dozen will avail themselves of the privilege.

So far, this has been a typical exchange. Once in a while we hear from the likes of Corky Scott at Dartmouth, who will post an annotated bibliography in answer to someone's question. More often, we throw our opinions and anecdotes into cyberspace like so many Frisbees. It's not easy to haul a book down from the shelf while you're working a keyboard, and not many of us have software as sophisticated as Dartmouth's with which to call up an online catalog and patch excerpts into our messages (I scribble information on Post-it notes and stick them on the plastic border of my screen).



From the University of Adelaide in Australia, Richard Harris points out that tracers differ by national origin, by caliber of the gun that is firing them, and even by the time of day they are used. Thus, in World War II the British Royal Air Force used red, green, and white for daylight but purple after dark to avoid impairing their gunners' night vision.

After contributions are posted from readers at the University of Idaho, a consulting firm in Oklahoma, a U.S. Army arsenal in New Jersey, and more from Sweden, the discussion veers into a technical argument.

"Tracers work by the burning of pure metals," observes Norman Purves, who spends his nights at a multinational telescope on Mauna Kea, Hawaii. "Sodium gives a pale orange color, calcium will be bright red.... With proper proportioning of metal constituents in a tracer bullet's jacket, virtually any color can be obtained. Even blue tracer bullets are possible!"

No, no! retorts Dave Pierson of Marlboro, Massachusetts. A computer engineer who dabbles in fireworks, Pierson argues that the color comes not from pure metals but from salts like strontium nitrate, "an almost universal red."

I can't resolve this debate, which seems to arise from the difference between ordnance and display and which, in any event, has strayed from the question, as newsgroup discussions are apt to do. (We also seem to have a disagreement about whether the "trace mix" is located in the bullet's metal jacket or in a pellet embedded in the base.) So I close with a personal observation from former Army officer Gene Kennedy in Houston.

What color are tracer bullets? "That depends on what color they are made to be," Kennedy sensibly replies. "The normal color used by the U.S. is red; the color most often used by the Soviets was green, but they also used red or red/orange."

Flying a Cobra helicopter gunship in the spring of 1971, then-Captain Kennedy saw more than the usual quota of tracer bullets during Operation Dewey Canyon, supporting the South Vietnamese invasion of Laos. "I myself much prefer red over green," he tells Will Christie, "since everything I fired was red and most of what was fired back at me was green."

—Daniel Ford

DAVID CLARK

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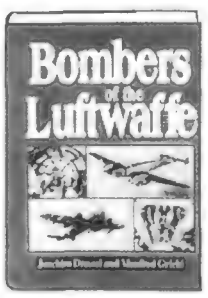

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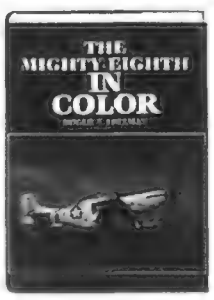

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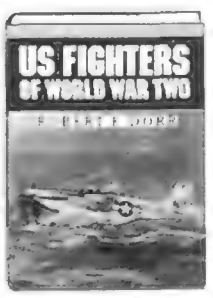

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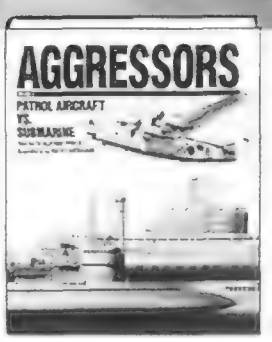

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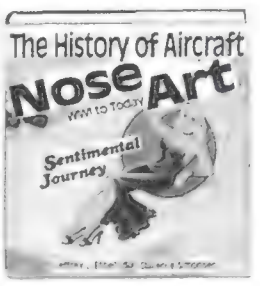

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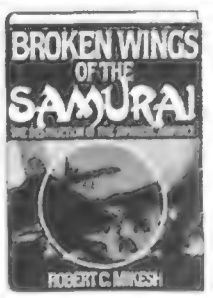

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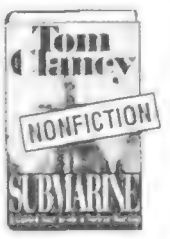

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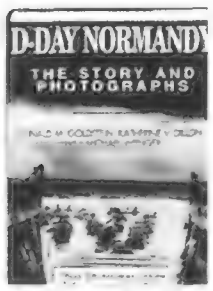

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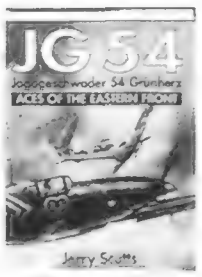

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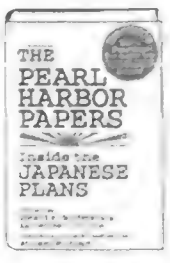

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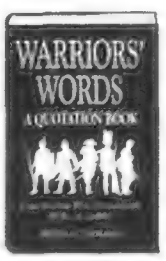

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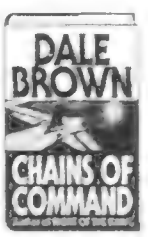

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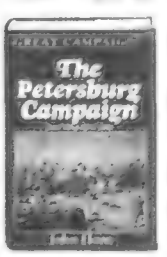

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REFLECTIONS ON THE COLD WAR

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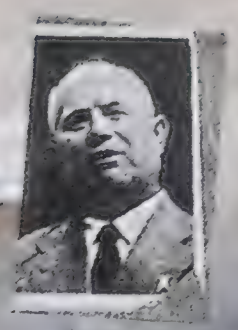
VOICE OF AMERICA

Beyond the Iron Curtain

At the height of the cold war, American ferret flights often flew into the Soviet Union to probe its defenses. Some didn't make it back.

by William E. Burrows

Illustrations by Paul Salmon



Captain John E. Roche would recall later that the scene through his Boeing RB-50G's plexiglass nose that early morning was soothingly ethereal: distant mountain peaks rising out of a calm gray mist, like a classic Chinese painting.

But the mountains were not Chinese. They were Siberian. And they were near Vladivostok, home port of the Soviet Union's Pacific fleet and therefore one of the most heavily guarded bastions in a dangerous and forbidden land. It was six o'clock in the morning, July 29, 1953.

The armistice ending the Korean war had been signed only two days before, causing jubilation and heavy partying in Roche's outfit, the 343rd Strategic Reconnaissance Squadron of the 55th Strategic Reconnaissance Wing, based at Japan's Yokota Air Base. The Soviets, however, were not so jubilant. On the last day of the war an American F-86 had shot down an unarmed Soviet Ilyushin Il-12 airliner as it made its way from Lu-shun, China, to Vladivostok. All 21 aboard were killed. The United States claimed that the airplane was shot down over North Korea, yet its wreckage came down inside Manchuria, which was technically off limits to United Nations aircraft (U.S. fighter pilots frequently poached in the "privileged sanctuary" anyway). The attack very likely figured in what was to happen to Roche's RB-50, no. 47145.

The hot war with North Korea may have been over, but the cold one remained intense. Within the "denied territory" of the Communist bloc there were uncounted weapons of every kind, some of them nuclear, that were tenaciously protected from Western eyes and ears. In the event of all-out war, enemy radar would have to be jammed, skirted, or destroyed so the attackers could reach their targets. That meant locating the Soviet radars and related electronic defenses and measuring their vital signs. That's what Roche's RB-50 was attempting to do.

Radar operates by sending out pulses of high-frequency radio signals. After the pulses hit a target they are reflected back as echoes and collected by an antenna. On an operator's radar screen the returned echoes appear as the familiar "blips." The time it takes the pulse to return to the antenna indicates how far away the target aircraft is; the direction from which the pulse is returned provides a pointer to the target; and changes in frequency indicate its relative speed and heading.

The radar's characteristics—its "signature"—can be measured in a variety of ways by sensitive receivers and recorded on tape. Parameters include frequency (how many waves per second it sends out), pulse repetition frequency (the intervals between signal transmissions when it receives echoes from previous signals), pulse length (the duration of the pulse, measured in millionths of a second), and beam width (the size of the signal's arc measured in degrees). These functions determine the radar's purpose: early warning, which operates over distances of hundreds of miles to warn of an attack; search, which works with missile batteries to track intruders more precisely; and fire control, which can lock onto an individual target like a searchlight

beam and feed data on it to a missile's fire control system.

Learning a radar's signature is also essential for developing ways to counter it. If an electronic countermeasures aircraft wants to jam an enemy radar effectively, its crew must know when the radar is sending out a pulse and when it is listening for returning echoes.

The first American "electronic reconnaissance" mission was flown by a modified B-24D in March 1943 to collect data on a Japanese radar on Kiska Island in the Aleutians. The flight was code-named "Ferret 1" after the domesticated polecat that enters the lairs of rats and other vermin to chase them out into the open, where they can be killed. The name was appropriate, since radar cannot be measured unless it is working, and ferrets often had to fly close enough to the devices to trigger a reaction and get them turned on.

In September 1946 a jury-rigged B-17G flew the first cold war ferret mission, sniffing out Soviet radar in northern Siberia. By the end of 1947, the ferret campaign was well under way. "Electronic reconnaissance flights [over Siberia] should be made as often as possible with the equipment and personnel available," read a top-secret order from that year to the Alaskan Air Command. "First priority of search missions should be assigned to the location and characteristics of radar stations in order to establish radar chains as well as operating schedules." Many reconnaissance planes probed directly over denied territory—Murmansk, Vladivostok, other parts of Siberia, Eastern Europe, and elsewhere—in brazen, dangerous, and always covert attempts to collect ever more intelligence.

The bits and pieces of unconnected radar data collected by individual ferrets were sent to Strategic Air Command headquarters in Omaha, Nebraska, where they were fitted together for use in the target folders that SAC crews would use on their bomb runs at the start of World War III. The information also went into the Target Data Inventory, a book that described the location, purpose, and details of enemy radar. TDIs were used to brief crews that went on all sorts of intelligence missions, including photo-reconnaissance runs and spy drops behind enemy lines.

The Navy used its own maritime patrol planes for ferreting, including Martin PBM Mariners and P4M-1 Mercators, Lockheed P2V Neptunes, and Consolidated PB4Y-2M Privateers. It was responsible for collecting radar data on the Soviets' Black Sea fleet, its northern fleet based at Severomorsk, and everything along the coast from North Korea to Sakhalin, including the Pacific fleet at Vladivostok. While the Black Sea forays were necessarily overflights, those in the Far East stayed well away from Soviet territorial waters, according to Carlos C. Campbell, who was a senior air intelligence officer in a patrol squadron based at Atsugi Air Base outside of Tokyo from 1960 to 1962. There were so many Soviet interceptors along the Vladivostok-Kamchatka corridor, Campbell says, that Navy crews called it the "Fresco Freeway" after the MiG-17's NATO code name. (The policy may have changed before Campbell's time: aviation machinist's mate Jack Lively, one of 10 fliers lost when his Neptune was shot down near Vladivostok on November 6, 1951, once bragged to his sister that some ferret crews "knew Vladivostok like the back of their hand because they flew over it so often.")

One flier once bragged to his sister that some ferret crews "knew Vladivostok like the back of their hand" because they flew over it so often.

Aerial ferret missions against the Soviet Union began falling off in the late 1960s. Part of the reason was that Soviet radar had become so powerful that U.S. aircraft could record the vital signs from neutral territory. In addition, primary responsibility for taking the pulse of all Soviet radar was shifted to ferret satellites, the first of which went up in May 1967. But some ferret flights did continue, leading to one of the last great tragedies of the cold war. On September 1, 1983, a Soviet fighter shot down Korean Air Lines flight 007, a Boeing 747 with 269 people aboard. The Soviets had mistaken the aircraft for one of the Boeing RC-135s that routinely collected intelligence in the area.

Officially, ferret missions never happened. Flying in communist airspace violated international law, and clandestine overflights would therefore have been embarrassing if made public, as proven when Soviet missiles downed Francis Gary Powers' U-2 in 1960. And the flights involved blatant spying, an undertaking that most Americans of the time naively considered unethical and distasteful at best. Initially, Air Force crews were under orders to tell their interrogators that they had been on a weather mission. But starting in 1949 they were told to claim that they had been on a "long range navigation training mission...since the Soviets can readily determine that no qualified weather personnel were on board the aircraft," in the words of an Air Force order.

The cover stories were considered necessary because of the risk that the ferret flights would be shot down. The first American ferret to fall victim to Soviet fighters was a Navy craft. The PB4Y-2 with its 10-man crew was shot down over the Baltic Sea on April 8, 1950. The four fighter pilots who destroyed the Privateer were awarded the Order of the Red Banner within a week. Three months later, Stalin's son used the incident to issue a warning to any who planned to follow. "Not one air pirate, no matter in what machine he flies, no matter how fast his machine moves and how high it flies, will dare cross the air boundary of our great peace-loving state," said Red Air Force lieutenant general Vassily Stalin.

Despite the dangers, ferrets flew a technical intelligence effort of immense proportion. "One day, I had 47 airplanes flying all over Russia," Air Force vice chief of staff Nathan F. Twining boasted in 1950.

Leonard L. Spangler Jr. monitored


"Gentlemen, there is no possible search or rescue capability on this mission. In the event you go down and survive to be captured, every effort will be made to effect your return, but no result can be promised."

Soviet and Eastern bloc radar and radio traffic from a ground station in Bremerhaven in the mid-1950s in order to locate the corridors of "dead spots" in the western USSR's radar chains. When one was found, Spangler says, the ferrets would fly "flights of 25 to 30 miles in" or really "deep penetrations" over vast stretches of territory. Most of the airplanes staged out of Rhine-Main Air Base in West Germany, Spangler says, but they also used bases in Norway, Greece, and Libya. Still others flew out of Mildenhall and Lakenheath in the British Isles, Atsugi, Misawa, and Iwakuni in Japan, Kadena on Okinawa, Sangley Point in the Philippines, and elsewhere. Recently declassified memos, orders, and correspondence suggest that as many as 20,000 ferret flights were made between the late '40s and the late '60s.

Richard J. Meyer is a retired Air Force lieutenant colonel who went on many ferret missions in RB-29s of the 72nd Strategic Reconnaissance Squadron. "In the summer of 1948 a few of us were called into a closed meeting and given a briefing on an upcoming secret mission that would penetrate deep into Soviet territory on a ferret mission," he recalls. They were told that the flights would be extremely hazardous and that participation would not be ordered. No one ever begged off, he explains, though everyone understood that playing chicken with Soviet air defenses was potentially deadly.

The aircraft would fly from Alaska to Japan on 18- to 24-hour flights and make the return flight a few days later. Each trip involved a long detour into Siberia, since radar was positioned well inland to protect key installations. "Secrecy was, of course, paramount," Meyer says. "We only knew when we were called into a briefing that we had been selected for the next ferret mission." Sometimes a particular type of radar—search, for example—had to be ferreted; at other times the airplanes were sent out to collect as much as they could in a given area. And since radar, like other intelligence targets, could be modified or replaced, there were always followup missions so that SAC's target folders could be updated (see "From the Crow's Nest," p. 33).

"I think that the thing most locked into my memory is the concluding words of each ferret mission briefing," Richard Meyer says of the deep penetrations. " 'Gentlemen, there is no possible search or rescue capability on this mission. In the event you go down and survive to be captured, every effort will be made to effect your return, but no result can be promised.' "

"We were jumped by MiG-15s, MiG-17s, and Yak-25s quite frequently. You go numb for about a second. Anybody who tells you he isn't scared isn't breathing."

Unlike other fliers, ferret crews feared clear skies, which left them naked. "The flights that penetrated far inland were the ones that were considered the most dangerous," Meyer explains. "If you were discovered, the only hope would be a cloud formation large enough to duck into before you were intercepted. The pilots, of course, constantly scanned the skies for a possible escape route while watching for any aircraft. It was a very vulnerable feeling to see all clear weather and no clouds in sight."

As obsessed as the Pentagon was with the possibility of a Soviet nuclear attack, the Soviets were equally certain that the ferret and other spy flights were paving the way for their country's obliteration. All foreign aircraft that approached or flew over the USSR and its proxies—even scheduled airliners—were assumed to be up to no good. Fighter pilots went after not only military prowlers but the occasional civil airliner that strayed over or too near the Soviet frontier. Like pitchers throwing beanballs to intimidate batters, Soviet airmen tended to use their cannons to keep their opponents nervous, respectful, and away from home plate.

Ferreting over or near denied territory was therefore a risky business. "We were jumped by MiG-15s, MiG-17s, and 'Flashlights' [the NATO code for twin-engine Yak-25s] quite frequently," Campbell recalls. "No pilot or crew member knows what will happen," he adds. "You go numb for about a second. Then you go into a reactive mode and loosen up. Anybody who tells you he isn't scared isn't breathing."

Not all of the MiGs encountered were aggressive. A history of the 55th Strategic Reconnaissance Wing shows a photo of a MiG-19 within a few feet of a ferret's left wing. Asked by a superior how the crew could tell the MiG's intentions, one wag reportedly quipped, "By the expression on the pilot's face."

John Roche saw neither a face nor a fighter when the attack came that July morning. No. 47145 had gotten within 20 miles of the Siberian coast, according to an official (and perhaps overly conservative) postmortem. At 6:15 it was alleged to have been cruising 26 miles off Cape Povorotny, just southeast of Vladivostok, at 20,000 feet. The six Ravens—the specialists who took the radar's pulse—were busily trying to fine-tune their radar-signal recordings when the MiGs struck. Roche heard what sounded like loud backfiring. The bomber immediately staggered as though it had been smashed on its left side by a huge fist, he later recalled. Cannon fire had torn into its number-one engine. While Captain Stanley O'Kelley, the aircraft commander, sounded the alarm to prepare to bail out and Roche feathered number one, a second attacker raked number four. The Pratt & Whitney Wasp Major caught fire immediately and started to disintegrate as its flames burned into the right wing. O'Kelley began to descend to the right as he depressurized the cabin for a bailout and yanked the bailout signal, which clanged like a school fire alarm. Then the weakened wing buckled and smashed into the fuselage with such force that it tore Roche out of his seat belt and sent him smashing into O'Kelley's instrument panel and finally into the greenhouse nose section nine feet away. The wing apparently also ripped

off 47145's tail. Roche was injured, but he managed to tumble out of a hatch and open his chute. The bomber took two and a half minutes to cartwheel into the Sea of Japan.

The operations officers responsible for monitoring the ferret's whereabouts were so afflicted by their armistice party hangovers that they failed to notice that the airplane had missed two of its checkpoints. Partly because of that, and also because the security-conscious operations officers took several hours to pass on the airplane's flight plan to the rescuers, no SB-29 reached the crash site until 5 p.m.

The crew of the first SB-29 in the general locale of the crash spotted at least 12 fast Soviet patrol boats that were "assumed to be proceeding to and from what was later determined as the crash area," according to a report by the 37th Air Rescue Squadron. A second rescue plane counted six or seven survivors before sea mist swallowed them and the boats that were looking for them.

Roche was picked up by a U.S. destroyer 20 hours after the crash. He was the only crewman rescued by the U.S. O'Kelley had floated with him for hours before drowning. Roche later maintained that he thought others had bailed out of the stricken aircraft, that he had heard what seemed like the voices of some of his 16 comrades somewhere in the mist, and that he had also heard the "*putt-putt-putt*" of boats that were so close their wakes washed over him. His belief that others had bailed out was later supported by a Russian who had manned an air defense battery in Vladivostok that morning and claimed to have seen seven parachutes blossom as 47145 fell to the sea. The final American tally was one crewman retrieved, three bodies recovered on the shores of Japan, and 13 missing.

The Air Force reacted by following the script: it insisted that the ferret had been on a navigational training flight. The following May, Roche, undoubt-

From the Crow's Nest

The technological battle of wits known as electronic warfare began in World War II under the name Project Raven. The men operating the equipment to detect, identify, and defeat enemy radar were officially known as radar observers but more often called Ravens. Eventually, these men became better known as Crows.

From 1957 until 1970, I was a Crow for the Air Force's 55th Strategic Reconnaissance Wing. For some of that time I flew aboard the RB-47H, an ugly, overweight, under-powered, unforgiving, uncomfortable, dangerous, and noisy airplane. All of us who flew in it eventually grew to love it.

The Crow compartment in the RB-47 was located in what would have been a regular B-47's bomb bay. It was a cramped compartment whose height—only four feet—forced Crows to move around on their knees. All three Crows had to cram into the cockpit for takeoff, then crawl down into the compartment. There we sat facing aft, in ejection seats, with solid banks of equipment—scopes, analyzers, receivers, recorders, controls—in front and to one side. Ravens Two and Three sat side by side in the compartment's rear, with barely enough room between their seats to squeeze through. Raven One was Crow Commander and sat in the right forward corner of the cabin. In addition to the banks of equipment in front of him and to his left, there was quite an array of video, digital, and analog recorders along the wall to his right and behind him.

On the day before a sortie into a "sensitive area," we received a briefing and were given the route, timing, latest intelligence, weather, and specific tasking. To do the job right required intensive study. From experience, a Crow could identify an intercepted signal from its sound and the parameters (frequency, pulse shape, pulse rate, type of modulation, type of scan, etc.) displayed on our various scopes and detectors. However, emitters were constantly being modified to increase capability or defeat our intercept and countermeasures. Our study was devoted primarily to detecting the latest changes.

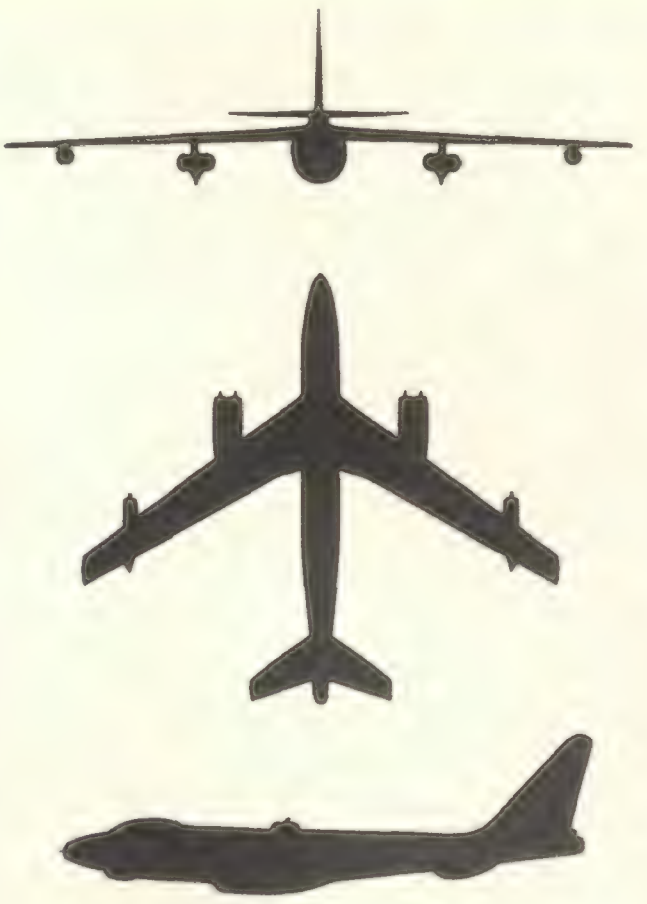
Before a mission we prepared a chart with the suspected locations of targets and likely defenses. At a prescribed point during the mission we began processing signals. The three Crows had a separate intercom system and kept one another informed about activity on assigned bands. When we intercepted certain signals, we knew we could soon expect associated emitters. We told one another of these intercepts with simple code words, such as "Spoon Rest," which indicated the SA-2 missile radars were about to start tracking our RB-47. One Crow would then search for the target-tracking radar while another looked for the missile guidance signal. We kept our tipoffs to short, simple words to save time and avoid distractions, because our chief means of detecting signals was with our ears. In the small band to which each receiver was tuned, there could be dozens of signals. On the scopes they could look the same, especially those at the higher frequencies. A trained ear could hear the correct radar but couldn't see it buried beneath 30 similar signals.

We recorded the intercepts in analog, digital, and video formats and took movie, strip, and still photography of the signals from the various analyzers and oscilloscopes. By switching to one of the direction-finding antennas, which spun at 300 rpm, we could log several bearings to pinpoint the emitters' locations. All observations and actions were annotated on our audio recorders and written down in the logs. On a good mission in a hot area such as the ones we flew out of Turkey or Japan, the Crows wouldn't even have time to stop for a second and change film and tape.

When the Soviets sent fighters up to run us off, it was Raven One who had to handle them. He could detect fighters long before the pilots could see them and was able to determine their type from their radars and weapons. He supplied identification, number, direction, and range to the RB-47 pilots so they could start looking for them. Raven One also reported when a fighter went into lock-on mode in preparation to fire. When he demonstrated hostile intent we aborted the mission and got the hell out of there, while Raven One deprived the fighters of tracking data with chaff and jammers.

On the other end of the spectrum were the long, dull flights when nothing happened. Those sorties gave us time to dream up pranks. Since a Crow's greatest ambition was to pick up a new or unusual signal, we sometimes made up our own. We brought kazoos, noise makers, Japanese battery-operated toys, whistles, signal generators, and other devices to stump the analysts. Once we brought a cricket along and recorded its chirping, which we mixed with the navigation radar pulse and electrical noise from a fuel boost pump. We recorded and photographed the result and called it a new signal, speculating that it was most likely from an advanced fighter radar. Two weeks later the analysts' report came back. They had properly identified the nav radar, the boost pump, and the cricket. As a crowning blow, they had even determined the cabin temperature at the time of the recording and the sex of the cricket!

—Bruce Bailey



The Strato-Spy

The first designs of the B-47 Stratojet envisioned a straight-wing aircraft, but when World War II ended and engineers got a look at German aerodynamic studies, they gave the craft swept wings. The RB-47H configuration differed from the bomber versions in that it had radomes in the nose, wings, and beneath the fuselage, and the bomb bay was transformed into a compartment for the Ravens. Powered by six 6,000-pound-thrust General Electric J47-GE-25 engines, the RB-47H, like all B-47s, took a long time to take off, but once in the air was fast enough to cause difficulty when refueling from a Boeing KC-97 tanker. The slower propeller-driven tanker could keep above the jet's stall speed only in a full-power descent.

edly thinking about his security oath, affirmed the cover story and described the attack and rescue in a 49-page deposition. The state department proclaimed that the RB-50 (which it studiously referred to as a B-50) was shot down in international airspace and demanded $2,785,492.94, which included replacement of the aircraft and compensation for the "wrongful deaths" of crewmen or their "wrongful and unlawful detention." State's lengthy claim also noted that, with one exception, "all members of the crew...bailed out of the aircraft, or parachuted, into the Sea of Japan."

The Soviets filed a counterclaim of $1,861,450 for the loss of the Il-12 on July 27. The unusual presence of the patrol boats in the vicinity of 47145's crash site suggested that the RB-50 had been shot down in retaliation for the attack and that the boats were positioned to pick up whatever men and equipment they could spirit away before other Americans arrived.

Korotkov maintained that the six captured crewmen in Roche's flight were taken by an elite KGB unit and sent to Gadhala prison in south-central Siberia.

While ferret crews faced the same dangers as their brethren in fighters and bombers, they bore the additional burden of risking their lives without the knowledge of the citizens for whom they flew. The twilight war carried not only the threat of capture or death but the assurance of official silence or disavowal that is the fate of all spies, whether they wield daggers or digital analyzers. Dogfighting, bombing, and test flying were high-visibility occupations that produced heroes. But the intelligence collectors prowled, unheralded, in the cold war's netherworld like their earthbound counterparts in trenchcoats. So reconnaissance crews, ferrets included, lived their professions in reverse. When they completed their missions satisfactorily they were publicly ignored, and when they were killed or captured they were a source of embarrassment. In all, 90 fliers remain unaccounted for from 10 ferret shootdowns. Inquiries by family members about their loved ones and the nature of the mission, like other such inquiries, disappeared into a bureaucratic quagmire of evasion and double-talk.

Major Samuel N. Busch was shot down in an RB-29 ferret over the Sea of Japan on June 13, 1952, and today his sister, Charlotte Mitnik, has a pile of official answers to her requests for information. But they don't inspire confidence. One, sent in 1987 from the Department of the Air Force's Military Personnel Center, is typical of hundreds sent to families. It states that Busch was killed in a "military aircraft accident" and declared dead on November 15, 1955. Mitnik was left to reflect on several discrepancies: that a number of eyewitnesses and compelling evidence indicated her brother was not killed but was taken prisoner; that the aircraft did not suffer an "accident" but was shot down; and that Busch's death was not officially declared until more than three years after his airplane crashed into the sea.

"Making these cases public would have been embarrassing to defense agencies because they would have had to admit they were spying and that they bungled it," Leonard Meeker of the state department's legal office told *U.S. News and World Report* last year. The real reason for not vigorously pursuing the matter of the missing ferrets, in the words of one who knows the situation firsthand, is that "it was a problem without a solution." Any president who publicly acknowledged the possible existence of captive ferret and other crews would come under enormous pressure to gain their release or face the political consequences. In *Soldiers of Misfortune*, a 1992 book on POWs and MIAs, authors James Sander, Mark Sauter, and Cort Kirkwood quote a senior intelligence advisor to President Eisenhower as saying that Ike readily agreed to "write off" American POWs in the Soviet Union because it was unlikely that they had survived and because the Soviets would never admit having them anyway.

But in 1991, with the cold war over and Moscow needing Washington's help, Presidents George Bush and Boris Yeltsin agreed to establish Task Force Russia. The joint commission, headed by Malcolm Toon, a former U.S. ambassador to the Soviet Union, was supposed to investigate the whereabouts of any Americans who might have fallen into Soviet hands from World War II onward. The group searched Soviet and U.S. archives, interviewed veterans on both sides, and questioned the families of the downed airmen as well as survivors of Chinese prison camps and the Russian gulags. At least one member of the task force (who requested anonymity) believes that some of the ferret fliers who remain unaccounted for could well have been captured and imprisoned, although he does not believe any survived.

Bruce Sanderson's father, Lieutenant Warren J. Sanderson, was on Roche's RB-50. Bruce, together with others in a network of ferret families that stay in close touch with one another, maintains that Task Force Russia was originally sincere about probing the fate of the MIAs but that it has lately reduced itself to "placating" their families. This is all the more galling in the case of his father, he adds, because a trip to Moscow in the fall of 1992 turned up a Colonel Gavril Korotkov, now a military historian, who recalled the interrogations of six crewmen from the RB-50 in Vladivostok. Peter C. Johnson, a Russian-speaking former military intelligence officer who was also involved in tracking the whereabouts of ferret crews, says that "the chances are pretty good" that at least six of 47145's crew wound up in Soviet hands. The evidence, he adds, is "pretty convincing," such as testimony by a member of an anti-aircraft battery in Vladivostok who saw MiGs chasing the ferret, counted seven parachutes, and watched patrol boats speed to the wreckage area.

Convincing indeed. Korotkov, who was an intelligence officer at the time, maintained that the six captured crewmen in Roche's flight, including Warren Sanderson, were taken by an elite KGB counter-espionage unit. Since none of the Americans agreed to "work for" their captors, he added, they were classified as spies rather than ordinary prisoners of war and sent to Gadhala prison in south-central Siberia.

Members of Task Force Russia blame sloppy record keeping for their failure to track down the Americans, but Korotkov disagreed. He said the record is secreted in the Russian archives but is heavily restricted. "I think they've failed because the people [Russians] involved are still alive and they don't want it all out in the open," Korotkov told an interviewer for a BBC documentary last winter. "They want neither their actions nor the system exposed. If Bruce [Sanderson] can hear me or see me he should not lose hope. There will be a day when he finds out the details of his father's death."

"We've been lied to over the years for such a long time. It's not what they say, it's what they do," Charlotte Mitnik says, echoing the frustration of the other families. "Citizens need to know that the government will get the men home, alive or dead, whether 20 years later or 40 years later. These men didn't have a Purple Heart, an Air Medal—nothing, absolutely nothing. I want these men to be honored as they should have been."

Honored, perhaps, but not publicly, if that would provoke a confrontation that could further weaken Yeltsin's increasingly precarious hold on a reformist government. With anarchy on the rise and vehement ultra-nationalists grabbing for power in Russia, Washington is unwilling to embarrass Yeltsin, particularly over a handful of airmen who lost their lives in the shadow of a conflict that has faded and been replaced by new dangers.

Abandoning the ferret program and its ghosts to limbo may be the final irony in the record of one of the cold war's most enigmatic operations. "Eisenhower didn't confront them because they were our enemies," Peter Johnson says. "And we don't confront them because they are our friends."

Thirty Seconds Over Hollywood

What's real and what's faked in flying-action movies like *Clear and Present Danger*? A behind-the-scenes look.

by Joseph Bourque

Photographs by Ross Harrison Koty

Somewhere over the Gulf of Mexico, a Beech King Air loaded with cocaine cruises toward a remote landing strip in Florida. High above, a U.S. Air Force pilot in an F-15 spots the twin-engine turboprop on radar. He swoops down behind it, sending repeated radio calls, but the smuggler refuses to respond and begins flying evasively. The F-15 pilot squeezes off a burst of fire from his 20mm cannon, and the King Air explodes and plummets into the sea.

That's a scene you were supposed to see in Paramount's *Clear and Present Danger*, a flying-action movie scheduled for release this August. But the setup presented problems. "Something that was easy to do in Tom Clancy's book was much harder to do for real because one airplane is so much faster than the other," says producer Mace Neufeld. "So we planned the visual effects with a combination of real airplanes, models, and computer graphics." The scene was going to cost some serious money.

When the action was sketched out in storyboards—a series of rough drawings that show how each shot will appear on the screen—Neufeld pondered it, then said, "This is boring. There's nothing new here. I've shot down lots of planes in other movies." The scene finally collapsed when the script came back from the Department of Defense. The department must approve any movie that uses its hardware (see "Keeping the Pentagon Happy," p. 39), and it pointed out that according to the rules of engagement, an Air Force pilot cannot shoot down a civilian airplane that is not clearly hostile, even if it is carrying drugs.

When filmmakers set out to produce a blockbuster movie with sophisticated aircraft ranging from Army MH-60L

To get a variety of air-to-air shots for Clear and Present Danger, *Michael Benson filmed two Blackhawk helicopters from a Bell JetRanger, and also shot one Blackhawk while riding in another (above).*

When the CPD *film crew set up operations in rural Mexico, the activity got the residents' attention. The movie is the second in which Harrison Ford plays Jack Ryan, a recurring hero in Tom Clancy's novels (below).*

CPD *crew members prepare the Wescam, a camera that can be mounted outside a helicopter and remote-controlled by an operator riding inside (opposite).*

Blackhawk helicopters to a Navy F/A-18 Hornet armed with a smart bomb, it's inevitable that they will run into problems like these. But what about movies featuring far simpler aircraft? *Amelia Earhart: The Final Flight*, which aired this June on Turner Network Television, focuses on 1930s-era propeller-driven airplanes. But the making of *Amelia* produced headaches of its own. In one scene Earhart's Lockheed 10 Electra is supposed to make a forced landing with smoke and fire streaming from the left engine. When a twin-engine Beech dressed to look like an Electra appeared on location, however, one of the openings for the fire-making apparatus had been installed on the outboard side of the engine, clearly visible to the camera. Electras just didn't have holes there. A morning's work restored the proper look, but then, despite successful ground tests, the equipment wouldn't produce any fire in flight. Eventually the filmmakers settled for an engine that spewed only smoke—a simple matter of injecting oil into the exhaust manifold.

Aviation's frequent visits to Hollywood always create plenty of technical and artistic challenges. Sometimes the solutions require more Hollywood than aviation. For the troublesome scene in *Clear and Present Danger*, the filmmakers substituted one in which ground forces locate the drug-running airplane in the jungle and blow it up with a timed charge. But when a scene demands aerial action, most of the work is shouldered by a group known as the second unit, usually consisting of a director, an aerial coordinator, a cinematographer, pilots, and support people.

Clear and Present Danger is the kind of movie that keeps a second unit hopping. The feature tells the story of hero Jack Ryan's attempts to rescue a special force of U.S. troops that has been stranded in the jungles of Colombia during a drug-busting operation. One recent morning on location in Jalapa, Mexico, the second unit prepared to shoot a scene in which two Blackhawk helicopters deposit troops into the jungle. Aerial coordinator Craig Hosking would be flying a camera-equipped Bell JetRanger III helicopter carrying unit director David Ellis and cinematographer Michael Benson. Before taking

off, Hosking repeated safety guidelines for the Army Blackhawk pilots: "We'll be pretty tight to the ground and to one another. If it gets too hairy just break away and we'll re-form."

The Blackhawks swaggered off into the early-morning sky, the camera ship flitting above and behind them. Entering a canyon, the Blackhawks began following the rocky contours in a series of stomach-churning turns. At the inside of a particularly tight maneuver, it appeared as though the three-craft formation would force Hosking's ship into a rock wall.

"Wall? What wall?" Hosking joked afterward. Then he added, "I always make sure I have a way out. I had enough airspeed to go straight up if I had to, but I was able to jog around a little tree sticking out and get right back into position." Ellis and Benson offered no

Keeping the Pentagon Happy

When filmmakers need military support for their productions, they must submit to a review by the Department of Defense, where Philip M. Strub has the final say on whether any of the armed services will participate in a movie project. "We would prefer that people come to us with a concept so we can tell them our concerns right from the beginning," he says. "But a more typical scenario is one where a producer mails me a script, and after a review we either refuse support or enter into a process of negotiation with the movie company." To get support for *Clear and Present Danger*, producer Mace Neufeld sent a completed script, since he had plenty of experience in negotiating with the DOD, having produced *Patriot Games*, *The Hunt for Red October*, and *Flight of the Intruder*.

The military checks every script to see what the film tells the public about the role of the military, and how authentically it does so. It also doesn't hurt if the movie is likely to help recruitment efforts. When *Top Gun* was released, the Navy wisely set up recruiting booths in the theater lobbies.

Once the DOD decides it is willing to enter into negotiations with a movie company, it assigns a project officer to hash out the specifics, such as ridding the story of things the military considers taboo. Says Army major David A. Georgi, the project officer assigned to *Clear and Present Danger*, "We never do a film that advocates the overthrow of the U.S. government. *Clear and Present Danger* had some problems there. The original script trashed the presidency, so there had to be some compromises." Other large red flags are violence that is considered too graphic and sex that is deemed excessive. "We can stand some sexual content," says Georgi, "but we don't want to support *Debbie Does Dallas*." Overall, military personnel depicted in the movies have to behave relatively decently. "After the Tailhook scandal, *Top Gun* would never be made today because of its hard-drinking, macho, womanizing image of Navy pilots," Georgi says.

Some script negotiations prompt fairly substantial changes. In an early script of *Clear and Present Danger*, hero Jack Ryan talks a military pilot into flying a single Blackhawk helicopter, without orders, to rescue U.S. soldiers stranded in Colombia. The DOD objected. "A military pilot wouldn't make that decision," says Strub. "He'd be crucified. And we wouldn't send in a single helicopter. We'd send in a show of force, at least two or three helicopters, sufficient to protect our assets." But producer Neufeld points out, "A huge firefight with that much hardware would have been very difficult to film and it would have detracted from our hero." Instead, the filmmakers decided to have Ryan commandeer a civilian helicopter and a reluctant civilian pilot. The DOD was disappointed. "The full firefight would have been another opportunity to demonstrate military readiness and capability to the American public," says Strub.

After a script has been approved, Strub and the project officer must locate the necessary resources and clarify exactly what the movie company will have to pay. The basic rule of thumb is that the military—and thus the taxpayer—will bear no expense beyond what it costs to maintain the same resources when they're not being used in a movie. For the film company, that usually means paying for fuel and repairs. Other expenses are calculated on a case-by-case basis.

Some movies present unique problems. For *Clear and Present Danger*, one of the very few major features filmed with military support outside the United States, the DOD had to negotiate carefully with the Mexican government. Bringing in military helicopters with full guns while a revolution was being waged in the nearby state of Chiapas required caution.

During the filming, both Strub and Georgi wrangled with the filmmakers over dozens of details, from whether soldiers could wear Rambo-style headbands to the technicalities of radio communications to the proper time for wearing night-vision goggles. But after the shooting was over, Neufeld maintained that "Major Georgi and the DOD were terrific. They helped us produce a more authentic film." Because Hollywood needs the military's support and the military needs the exposure, both sides usually see the wisdom of working toward compromise.

MARK WEXLER (4)

CHAD SLATTERY

comment. After all, they'd just entrusted him with their lives.

A few weeks earlier Hosking had been on the trusting end, serving as second unit director and aerial coordinator for the Amelia Earhart production. He and cinematographer David Nowell were crammed into the nose of a North American B-25 Mitchell with Steve Hinton at the controls. The World War II bomber had been rented from the Planes of Fame Flying Museum in Chino, California; equipped with camera mounts in the nose and tail, it's one of the aircraft routinely used for air-to-air filming.

Nowell squatted behind the nose camera, filming the scene in which Earhart makes her forced landing. While the camera rolled, pilot Skip Evans skimmed the treetops in the Beechcraft, his left engine smoking. "Skip, make the smoke more intermittent," Hosking radioed, his voice calm even though the B-25, flying 140 mph, loomed a scant ten or twelve feet behind the other airplane. "Ease up a bit, Steve," he told his pilot. "David can't keep him in the frame." Hinton backed off the throttles a little and the Beechcraft pulled ahead into position. The chase continued for two hours.

The crew members' trust in one another is an investment that inevitably accrues a dividend. Second unit people are an extended family, complete with legendary ancestors and a well-known hierarchy. According to Hosking, when

filmmakers are planning a movie that will require flying, they will usually approach one of the half a dozen best known regulars. "If you're the new guy trying to break in," he adds, "you'll work only if every known quantity is taken."

It's not a malicious exclusion. "Once you put together a team that works well," says David Ellis, "you try to keep them together for the next job." It helps minimize the danger. The meticulous concentration that's always needed to fly airplanes in tight spaces is all the more difficult to achieve during the making of a movie, given the demands of lighting, backgrounds, points of view, and even costumes. For safety's sake, everyone has to do the job with a minimum of fuss.

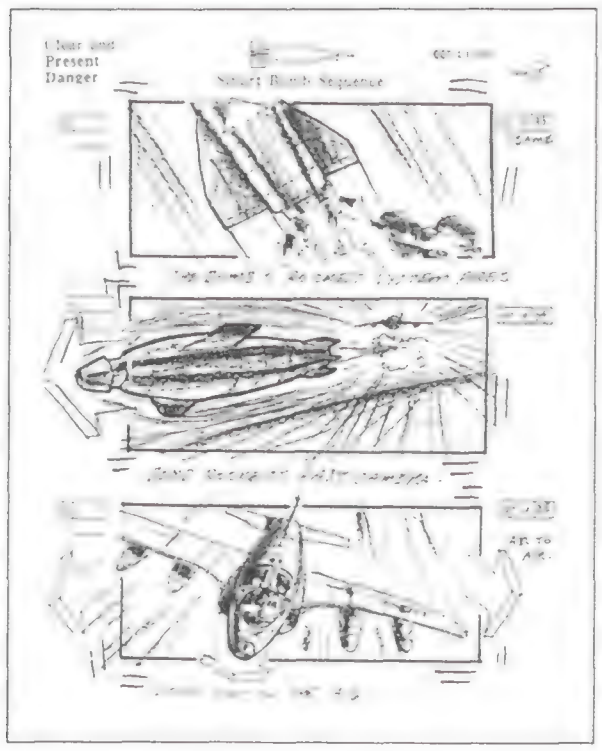
Hosking says it was luck that helped him break into the business seven years ago. "I came to Los Angeles thinking it would take me about five years to establish myself," he says. "But Jim Gavin [one of the living legends in the flying-movie business] introduced me to the owner of Cinema Air, who had two helicopters dedicated to the film industry that weren't working very much. We negotiated a deal." Hosking's "luck" was likely helped by the reputation he had established as an airshow stunt pi-

In Amelia Earhart: The Final Flight, *Diane Keaton (above) played the flier in the ground shots, which included both a real airplane (a Beech twin engine decked out like a Lockheed Electra) and a mockup—a Beech fuselage with fake engines and propellers (opposite, bottom). For the flying scenes, pilots stepped in. Skip Evans (opposite, top right) did an "emergency landing," while Craig Hosking executed the groundloop that got Earhart some unwanted publicity (opposite, top left).*

lot—he is the only human being ever to take off and land in an upside-down airplane (a Pitts with landing gear on the top as well as the bottom).

Most often, getting started in the stunt pilot business depends on owning or having guaranteed access to airplanes or helicopters. Hinton has long served as the director of operations for the Planes of Fame Flying Museum and is now its president. "We have unique planes and a lot of the work we get is because we have those planes," he says. Skip Evans bought his own. "I always had an airplane around, but I started buying old airplanes and fixing them up," he recounts. "Wound up with a couple of DC-3s, a couple of twin Otters, and a twin Beech. I got into the movie business when someone wanted those airplanes and I had them."

The roads to advancement are varied, but Hosking's is fairly typical. He used his initial experience as camera and stunt pilot to lever himself into aerial coordinator jobs, in charge of such details as aircraft procurement, modifications, maintenance, and scheduling. Then he maneuvered that combination



PARAMOUNT PICTURES

Storyboards—rough sketches depicting scenes shot by shot—helped CPD's *aerial coordinator Craig Hosking (above, right) brief Army Blackhawk pilots on how to fly for the camera. Some helicopter scenes were shot on the ground, such as one with actor Willem Dafoe (below, center). The blue screens (opposite) provided a background that was easy to remove and replace with footage of the sky.*

of experience into assignments as second unit director, managing both artistic and technical operations.

Once they've achieved a place among second unit regulars, crew members usually stay passionately committed to the work. "I love my job," says cinematographer Michael Benson. "I just love going to work every morning." In addition to the aesthetic calling of creating an illusion viewers will believe in, the money is good—very, very good. A director of photography can make from $5,000 to $15,000 per week. Minimum Screen Actors Guild scale for pilots is $877 per day even if they don't actually fly. Stunts pay extra.

The generous pay is balanced by the risks second unit crew members face. Examples of the dangers are plentiful enough. Paul Mantz, perhaps the most famous Hollywood stunt pilot, died in 1965 during the filming of *Flight of the Phoenix* when a wheel hit a chuck hole on landing and his cobbled-up airplane broke apart. Ironically, the scene was already on film, but the director had wanted one more take for backup. While doing an inverted flat spin in a Pitts Special for *Top Gun*, stunt pilot Art Scholl crashed into the ocean. His last transmission, "I've really got a problem," suggests some kind of equipment failure. And during the filming of *Catch-22*, cinematographer Johnny Jorden, who was not wearing a safety harness, fell out of a B-25 camera plane's open tail and tumbled to his death.

While on location at Santa Catalina Island in California, *Amelia Earhart* pilot Skip Evans made perhaps the most common mistake possible in a retractable-gear aircraft: he came in for a landing with the wheels up. Evans had done a series of tricky maneuvers for several takes. When he was asked to alter the sequence, a checklist item was forgotten in a very busy cockpit. "As I settled down, I was still running the airspeed numbers through my head when I noticed the right prop digging into the runway," he recalled later. "So I hit the power and got it back up. Ruined the prop though. And I apologized to Catalina for chewing up their runway." A lesser pilot would have crashed.

Fortunately, most stunts, or "gags," as the pilots call them, are performed without mishap. Paul Mantz launched his career by pulling off a gag for the 1932 movie *Air Mail* that all the regulars refused to attempt. Buffeted by a quirky desert wind, he flew a biplane through a hangar doorway that gave him very little clearance. (The stunt was re-created in the 1988 television

movie *Pancho Barnes*, about a famous woman stunt pilot and air racer of the 1930s.) This year's *Terminal Velocity* features a dramatic stunt with an old-fashioned flavor: an aerial scene in which stuntman Jeff Habberstad clambers onto the top wing of a Waco and then makes his way onto the tailgate of a C-123 cargo plane flying nearby. To minimize the danger of the Waco jumping up when relieved of his weight, Habberstad had to grab the C-123's tailgate and let the Waco drop away, leaving him dangling for a nerve-wracking moment before he could pull himself onto the cargo plane.

A few days after the Catalina episode, Skip Evans, flying a second Beechcraft bought especially for bashing and crashing, went on to simulate Earhart's emergency landing perfectly, coming in with the left engine smoking and just the right amount of panicky wobble in the wings. About 15 feet off the ground he whacked solidly into a eucalyptus tree, then limped to a landing with a bent prop and damaged wing.

Hosking did one of the important gags for *Amelia* himself—the ground-loop Earhart made in Hawaii that ended her first attempt at a round-the-world flight. The Beechcraft junker was equipped with explosive devices to simulate the forces that sheared off Earhart's landing gear. Before attempting the stunt, Hosking downplayed the danger. "There's virtually no risk," he said. We're installing a cockpit roll bar [to brace the cockpit should the airplane roll on its back], and I'll pump CO2 into the gas tanks just before impact to minimize fire danger. I'll wear a fireproof suit and a helmet." And, he failed to mention, an Amelia wig over the helmet.

At about 60 mph Hosking blasted away the landing gear. The plane flopped on its belly, then ground down the runway and veered off into the turf, stopping in exactly the right place for the cameras. The stunt looked deceptively easy—so easy, in fact, that it was hard to envision the scene having much drama. No matter. In the final version of the scene, interior and exterior footage from five different cameras was edited together, then followed by shots of Amelia (played by Diane Keaton) and company fleeing the wreck, which had been rigged with fake smoke. It was convincingly exciting.

When he hears about the ground-loop scene, design engineer Ralph Kerr says, "I don't even want to be in the same state when that happens." His company, Image Engineering, produces the special effects that make such potentially risky stunts unnecessary. For the opening scene of the Mel Gibson movie *Forever Young*, in which a B-25 dives toward the ground, then levels off just at ground level and bellies in, Image Engineering swung a one-third-scale model on a long cable from a crane to show the arc of the airplane leveling off. For the last part of the scene, a tow truck hauled a real B-25 along the ground at 60 mph.

Provided they're realistic enough, models find plenty of uses in the movies. They are "flown" down wires, dropped off buildings, and dragged through water. They're also superimposed on whole miniature cities and realistic background paintings. Dream Quest Images used that method for the spoof *Hot Shots*, most notably for the scene in which a jet screeches to a halt in midair, flips around, and takes off again to the sound of screeching tires.

The growing incursion of special effects has not escaped the notice of the second unit regulars. Hosking is optimistic: "I think there will always be a need to shoot things for real. You can never entirely replace the subtleties you get with the human element pro-

vided by the stunt people." Cinematographer David Nowell isn't quite so sure. "Computer-generated images might knock us out of some jobs," he says. "There will always be a need for some background stuff, but I suppose there will be some films where the real airplane no longer exists."

Even when real airplanes are used, special effects can come in handy. Clay Lacy, who owns and flies four camera-platform Learjets, recalls the rather simple trickery employed in *Top Gun* to show one jet flying inverted above another, canopies just inches apart. "We tried it for real," says Lacy, "but it was either not impressive enough or too risky. You can imagine where the tails were when they tried to get close. So we shot one jet at the bottom of the frame against a clear blue sky, then separately shot the other inverted at the top of the frame. Then we just put the two pieces of film together in an optical printer"—a machine that merges several pieces of film into one.

In *Clear and Present Danger*, one aerial sequence demonstrates how real gags and computerized effects can be merged into a seamless whole. The scene called for an F/A-18 to take off from an aircraft carrier, fly to a drug lord's hacienda, and drop a smart bomb on it.

"The director wants the audience to follow the bomb all the way to the target," explains visual effects supervisor Robert Grasmere.

First Hosking took a camera crew aboard the USS *Kitty Hawk*, off the coast of San Diego, to film an F/A-18 being armed with a smart bomb (an inert one), then raised to the deck and launched. A week or so later Hosking took a camera crew to Fallon, Nevada, where, shooting from one of Clay Lacy's Learjets, they filmed the F/A-18 in flight, both from below and from the side. They also shot footage of clouds, to be used later with special effects. On the ground, a camera filmed "insert" shots of a hand pushing buttons in the cockpit.

Because actually filming the bomb's journey all the way from the jet's launch to detonation was impossible, the filmmakers used a computer to draw a detailed image of a smart bomb, using measurements from a military contractor. "It's fully three-dimensional with fins that actually work for guidance," says Grasmere.

When the re-creation was complete, technicians merged the computer graphic with the F/A-18 footage to simulate the jet dropping the bomb. The scene continues with the computer bomb "falling" through the cloud footage shot earlier. Realistic visual effects such as added camera shake and sunlight reflections were added. "We float along next to the bomb or behind it, and sometimes even inside it," says Grasmere. "We even degrade the image when it's supposed to be coming from the point of view of the video camera inside the bomb." The bomb's progress is intercut with shots of actors standing on a hill above the hacienda and aiming the laser that guides the bomb.

Finally, in Mexico, Hosking dove a camera-carrying helicopter toward the hacienda. That footage became the bomb's point of view during the last yards of its travel before it blows up the house—yes, a real house, actually demolished.

Another kind of fakery is necessary when actors are shown in the cockpit. Usually that kind of shooting is done in a mockup, but *Clear and Present Danger* needed only one day's worth of such scenes, so it was easier to use a real Blackhawk. The crew parked it inside a hangar and set up cameras to shoot through the windscreen and open doorways. For background, blue screens were hung around the helicopter; later, the optical printer would replace the blue with footage of outside scenery. When the camera crew was ready, actors playing the helicopter crew climbed in the cockpit and did their stuff, while a couple of crew members simulated motion by jumping up and down on the helicopter's tail.

Movie pilots often debate the believability of actors in these cockpit scenes. Steve Hinton has observed several actors at work, and his opinion is not generally favorable, though he doesn't always blame the actors. "Directors have this idea of what a pilot should be," he says. "Real pilots are like you and me, but directors want them to have the right scarf and the right sunglasses." Hinton flew with actor Brad Johnson for the movie *Always* to show how a pilot manipulates the controls of an A-26. But when Johnson reproduced the routine in front of the cameras he was told to give it "more action."

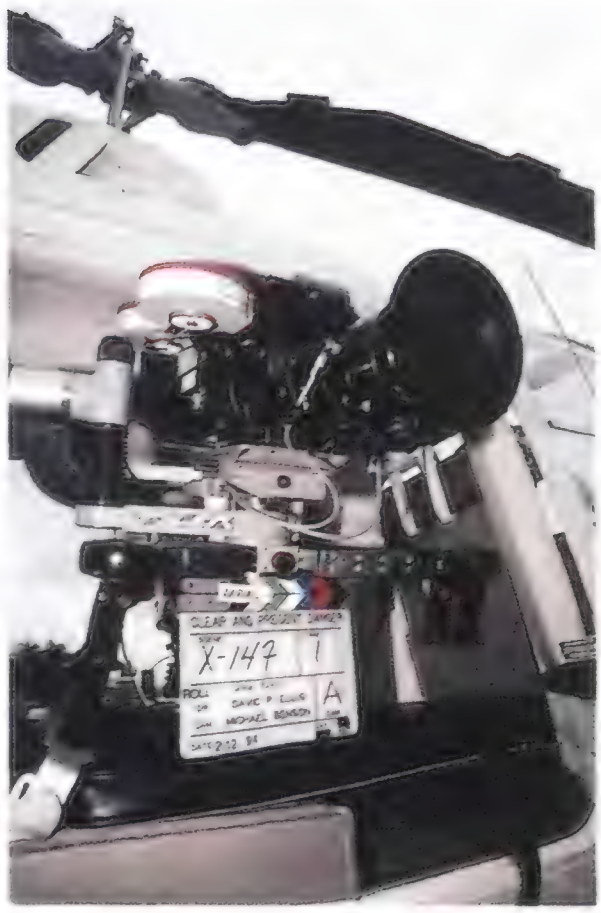
Still, technical realism isn't always the only, or even the best, measure of a successful illusion. For *Amelia Earhart*, Hosking served as technical advisor for the mockup scenes. Part of his responsibility was to show Diane Keaton how to handle the controls for the ground-loop scene in a realistic way. Hosking made no comment, but even a casual observer could see that Keaton was no pilot. And she knew it. During one rehearsal, she slammed the yoke and

This Bell UH-1 shell is rented out to movie makers. Here it was used for the forthcoming The Puppet Masters*; a week later it was on the set of* Clear and Present Danger.

CHAD SLATTERY

The presence of fearsome military aircraft could have caused trouble in politically unstable Mexico, but the U.S. military worked with the Mexican government to ensure that the filming would not be disruptive.

The Tyler camera mount is less stable than the Wescam but provides a bit more maneuverability.



shouted at director Yves Simoneau: "I don't know what I'm doing, Yves!"

In subsequent takes, Simoneau focused more tightly on Keaton's face and away from her hands, and by the third take it was Amelia Earhart in that cockpit, losing control of her airplane. This was one case in which psychological realism won out over the other varieties.

In any event, a few wrong moves won't doom a movie. On the set of *Clear and Present Danger*, Major Chip Bowlin, commander of the Georgia-based company that provided the Blackhawks, pointed out some violations of Army operations. Referring to a stunt with a parachutist, he said: "We wouldn't use a Blackhawk for a HALO [high-altitude, low-opening] jump." A Blackhawk's best approach is low and in the dark, he added, so it's more often used to deposit someone on the ground. Special ops people in the audience would know that. "How many people would that be?" asked director Phillip Noyce. "About a thousand or so," said Bowlin. "Then we won't worry about it," said Noyce. After all, we go to the movies by the millions. And in any case, if the illusion is sufficiently skillful, if it's made with the heart as well as the mind by people who love going to work every day, it will be real enough.

Bridging the Age Gap

Sheila E. Widnall,
Secretary of the
Air Force

This is a dynamic time for the American military, and we've been hearing a good deal about trends affecting military science and engineering—rightly so, given their impacts on the U.S. economy and national security. One important trend that will require increasing attention from the aerospace community in the coming years is the age gap in aeronautical engineering.

On one side of the gap are senior engineers, who have rich bases of experience in military aircraft design but are retiring or nearing retirement. Some belong to the cohort of design engineers who entered the field in large numbers in the 1950s and '60s. Their genius helped make the United States the premier aerospace nation of our time.

Then came the Vietnam era, and a gap was carved in the profession in the 1970s. This period was characterized by lower engineering enrollments and cutbacks of aerospace programs at universities.

On the other side of the gap are the younger technical staffs with far less hands-on experience designing military aircraft than their predecessors and fewer opportunities to acquire it as the defense community downsizes. A glance at the defense procurement budget dramatizes just how few: it is down in real terms by roughly 50 percent from its peak in the mid-1980s. In two more years, the defense market will likely be one-third of what it was a decade earlier.

Today's young aerospace professionals have far fewer opportunities to work in military aircraft design than their predecessors had.

As a consequence, fewer engineers are coming into the business, and some experienced ones are leaving earlier than planned. The aerospace industry—including the divisions that design combat aircraft—is consolidating. And design activity is decreasing even faster than the number of firms.

Compounding these trends is the fact that civilian and military aircraft design have less common ground than might be supposed. Stealth technology, weapon systems, and fighter engines, for example, have no civil counterparts. In these and other design aspects, defense stands alone.

The RAND Corporation has analyzed the age distributions of today's aeronautical engineers. It found the greatest numbers in the group nearing retirement: fully 40 percent of U.S. aeronautical engineers are over the age of 50. Their immediate replacements—those in the 40- to 49-year age group—make up only 25 percent of the force. The numbers continue to decline with age: 22 percent are in the 30- to 39-year age group and have worked on only one or two military aircraft designs. Finally, entry-level designers—those in their 20s, making up 13 percent of the workforce—stand on the far side of the gap. These professionals are talented and facile with computers. They have different approaches to engineering. And they have far fewer opportunities to work in military aircraft design than their predecessors had.

The RAND study points out that an engineer starting a career in the 1950s worked in an industry that flew 84 new military aircraft designs during his career. In the 1950s alone, 49 new fixed-wing aircraft flew. It was not unusual for design engineers who worked during the 1950s, '60s, and '70s to have contributed to about two dozen different designs during their careers. These engineers expanded and built on a base of expertise, but they're almost gone from industry.

Military aircraft design teams today work in an industry with far fewer designs. In fact, the four new designs that were scheduled to reach flight testing in the 1990s already have. People just entering the business may not have the opportunity to work on any actual aircraft programs. Unless we provide continuity in the ability to design military aircraft, the age gap is in danger of becoming a capability gap—and a threat to national security.

Part of the solution to the problem may lie in the development of technology demonstrators, carried through to flight test. These could keep some aerospace design firms viable, as well as firms that build subsystems and components. Technology demonstrators can also be built and tested for an order of magnitude less than a full-scale system.

The Air Force and Navy set up such a program last year—the Joint Advanced Strike Technology program. JAST will not directly culminate in the production of a new type of aircraft, but should provide the technology

A workforce trend is shaping the United States' aerospace future—for the worse.

basis for a replacement multi-role fighter around the year 2010. Some say the "A" in JAST should stand for "affordability." The emphasis of the program is on the development of technology for a leaner production of affordable aircraft. But over and above affordability, future fighter technologies have to stand up to the demands of 21st century warfare. So the premium is on speed, range, lethality, precision, and the further development of technologies like stealth, precision guidance, and cockpit information management. Equally important, however, the JAST program will give design experience to some younger aeronautical engineers.

But we need other mechanisms for transferring the wisdom and judgment of senior design engineers to younger generations. The material we have to work with in these young engineers is very good indeed: the analytic tools and automation are already there, and the ability to codify the design process and methodology is better than in the past. To expand on these strengths, the aerospace community needs an intellectual framework that will not merely replicate the design processes of the past but modernize, reshape, and advance them in ways a new generation understands. Universities, for example, might find new ways to generate and incorporate insights about the universality of the design process into their curricula, keeping in mind that, compared with earlier designs, modern aircraft design requires knowledge and integration of a broader range of engineering disciplines, such as information management and materials.

On a more personal level, aggressive mentoring can bridge the age gap. Mentoring has a profound impact on professional growth. Senior people can be much more than hiring officials and team leaders. They may have their greatest impact when they make time to teach and stretch the potential of those following so that we can all build for the future.

Part of the stretching process means giving young scientists and engineers truly meaningful work, especially in areas where they are underrepresented. Although this can apply to any industry, it is crucial for the defense industry. Participating in organizations that many government, academic, and industry leaders are affiliated with—advisory groups, boards, and committees—can provide new engineers with career-enhancing experiences. I intend to include more young professionals on the Air Force Scientific Advisory Board, for example. The idea is not to round out such groups for the sake of rounding them out. It is to challenge high-quality, creative people who've earned a place at the table: young women and men who can spark innovation, excel, and aim high.

Any organization that hopes to shape public policy needs backgrounds and perspectives that mirror society. Our diverse society no longer sits still and listens politely while one segment provides the expertise on which important decisions rest. Diversity in age—as well as gender, race, and more—brings credibility and balance. It offers greater alternatives to a lively range of problems involving the use of science and technology.

Of course, cultivating diversity in some disciplines is no easy feat, particularly when the participation of some groups still lags and multiple organizations are competing with one another for new entrants. Therefore, the Air Force is starting early. Our members try to reach out across America's communities to elementary and junior high school kids. We urge them to stay in school and out of trouble in order to keep career options open. We explain how math and science equip them for a variety of professions. And we tell them how the technical training they receive in the Air Force can make them competitive for life.

Challenging, mentoring, and including young people are just a few of the challenges shared by organizations that rely on leading-edge technology, but they are some of the biggest and the most important. The human dimension and workforce trends bear careful study; the people we cultivate in the 1990s go to the heart of what science and engineering will accomplish in the next century.

Unless we provide continuity in the ability to design military aircraft, the age gap is in danger of becoming a capability gap—and a threat to national security.

When you were a kid you made you
Maybe this is the year you ma

self a promise.
ke good on it.

So you never hit one out of Yankee Stadium, or headlined at the Garden like you planned. You can still drive a Corvette. And it's even more fun than you imagined it as a kid.

Because today's 'Vettes have 40 years' worth of Chevy engineering breakthroughs: The LT1 engine, one of the world's most advanced small-block production V8s. Dual air bags. The union of Bosch ABS brakes and ASR traction control. And no other Corvette has a cockpit quite as refined as this year's.

So, even though you've wanted a Corvette for as long as you could reach the accelerator, it's probably a good thing you waited until now. Because the 1994 Corvette is the best one yet.

CORVETTE GENUINE CHEVROLET

DESTINY IN SPACE

PHOTOS © 1991 LOCKHEED CORPORATION, SMITHSONIAN INSTITUTION

Space exploration has never looked as breathtakingly beautiful as it does in the newest IMAX feature.

That's the familiar shape of the space shuttle up there on the big screen, all right, but something about the image is different. The background, for one thing—it's a deep black that seems almost thick and fluid, and the orbiter seems to be in its embrace, like a dugout canoe in a swamp. Emanating from somewhere off-screen, a blue-white light the color of an electric arc washes over the orbiter's surface, revealing each tile, wrinkle, edge, and fastener with an intimacy that audiences have never experienced before. For the first time, here is a close-up view of the shuttle hard at work in its natural element—space. And it looks every inch a working machine, a little worn here and there after so many missions. Yet it also seems filled with purpose.

The footage appears in *Destiny in Space*, the third IMAX space film in a trilogy that

Placing a camera aboard a free-flying platform called Orfeus-SPAS allowed the producers of the newest IMAX release to obtain a whole new perspective on the shuttle. Equally spectacular are sequences filmed during the Hubble Space Telescope servicing mission.

which was retrieved by the shuttle in January 1990 (see "What Goes Up...," Aug./Sept. 1989), reveals the effects of six years of bombardment by tiny particles and highly reactive atomic oxygen as the satellite circled Earth. LDEF was launched to expose various materials to the harsh erosion of space in the hope of finding ways to resist such effects. As the film reveals, the challenges of survival in space are legion.

In fact, some destinations seem forever barred to humans. The role of robot explorers in taking us where we can't go has been growing as their electronics have been miniaturized, and the film presents a number of their singular accomplishments. Some computer-animated scenes of the surface of Venus—a truly inhospitable place, where the temperatures are hot enough to melt lead—show us that data from remote explorers can rival the excitement of human exploration. The images come from actual

opened with *The Dream Is Alive* and later added *Blue Planet.* Like its predecessors, the film features lavish photography shot from space by NASA astronauts. But *Destiny in Space* includes an important first: an IMAX camera loaded on a nearby satellite provides the first motion picture footage ever made of the orbiter from a second platform. In order to obtain the footage, producer Graeme Ferguson and his colleagues at IMAX removed a camera normally installed in the orbiter's cargo bay and placed it in the tiny free flier Orfeus-SPAS for a historic close-formation flight with *Discovery.* Preview audiences have been astonished by the sequence's clarity and eerie beauty.

Immediately after the opening credits there is another amazing sequence: a comparatively rare night launch of a shuttle shot only 100 feet from the pad. An IMAX camera protected by a hardened case with a quartz window photographed the ignition and liftoff from a perspective no human will ever experience.

Later, the scene shifts to a crew of astronauts performing experiments aboard the Spacelab facility in the shuttle's cargo bay. Many of the experiments are directed toward learning how human explorers can survive in the hostile combination of microgravity and intense radiation that characterizes the environment of space. The camera's close examination of the Long-Duration Exposure Facility, or LDEF,

remote sensors, then are compiled and reproduced in such a way that the viewer experiences a "flight" over the Venusian surface (see "Fast Forward on Venus," Oct./Nov. 1991). This particular sequence is the work of a division of the Jet Propulsion Laboratory in California. Similar footage based on data from Mars is used to simulate how the Red Planet's surface could be made more Earth-like by a process known as terraforming. Such futuristic concepts raise questions about what our course in planetary exploration should be (see "Viewport," page 4).

Images provided by the Hubble Space Telescope remind us of the unimaginable distances that separate us from objects outside our own solar system. Sequences photographed during the recent Hubble servicing mission include spectacular views of the astronauts at work on the orbiting observatory. When their work is completed, the telescope is gently returned to orbit so that it can send back even more eye-opening images from the remotest corners of the universe—some that raise as many questions as they answer. There are shapes and colors in these breathtaking images that appear utterly alien—and they are.

The 40-minute feature, which premiered on June 22, is shown four times daily. *Destiny in Space* was developed by the National Air and Space Museum and the Lockheed Corporation in cooperation with NASA, and it seems likely to take its place alongside the two other films in the trilogy as favorites of visitors to the Museum's Langley Theater.

Few films capture the working environment of space with the realism of the now-complete IMAX trilogy. Although the orbiting shuttle is beautiful to watch, its work environment is harsh, a point the film makes abundantly clear. Whatever our future course in planetary exploration, Destiny in Space leaves audiences with a feeling of expectation.

My Quest for

To white reporters in the 1920s, a black female aviator simply wasn't worth writing about.

by Doris L. Rich

Amelia Earhart and Bessie Coleman both began their flight training in January 1921. Both women flew World War I surplus aircraft. And though some two dozen women had taken to the air before them, both Coleman and Earhart would set aviation firsts before the end of the decade.

Bessie Coleman became the first black woman to fly, and in 1921 she became the first African American—man or woman—to earn a license from the Fédération Aéronautique Internationale. In 1928 Amelia Earhart became the first woman to fly the Atlantic. Though a nominal commander of the flight, Earhart never once put her hands on the controls and was in fact little more than a passenger, or as she herself said, "just a sack of potatoes."

To paraphrase George Orwell, however, some firsts appear to be more equal than others. Earhart soon became one of the ten most famous women of her time. Coleman, on the other hand, remained largely unknown, even to those in her own community. Though her performances at county-fair airshows sometimes drew as many as 10,000 spectators and were reported by the black press, her achievements, and the giant step she had taken for her race, went unacknowledged by the world at large.

A manicurist who was refused flying lessons in this country because of her gender and race, Coleman learned French in a Chicago language school and, with the backing of a black-newspaper editor, got her flight instruction and license in France, where racial tolerance was more widely practiced. After a second trip to Europe to learn aerobatics, she gave her first U.S. airshow at Glenn Curtiss' airfield on Long Island in 1922.

The archives of the National Air and Space Museum in Washington, D.C., are stacked with biographical files on

Queen Bess

COURTESY FREDDA DELACOEUR

The first black woman to fly an airplane, Bessie Coleman hoped that her achievements would inspire other blacks to get their wings.

pioneer women pilots, many unacknowledged by any but aviation historians. When I first began work on *Queen Bess: Daredevil Aviator*, a biography of Coleman, her file was among the slimmest. In addition to a replica of the pilot's license the Fédération Aéronautique Internationale in Paris issued her on June 15, 1921 (two years before Earhart received hers from the National Aeronautic Association, the U.S. chapter of the FAI), it contained three magazine articles, a brief memoir written by her late sister, Elois Patterson, and a press release from the Department of Transportation based on the memoir.

When I found the copy of the FAI license, my curiosity had already been piqued by the handful of rare, disconnected, and often ambiguous references to Coleman I had run across during five and a half years of research for a book on Earhart. The attractive face looking up at me was the only black one I had ever seen on the licenses issued to women before World War II. That alone might have compelled me to look for more information. But it was the 5,000-word Patterson memoir—sketchy as it was and rife with errors as it would turn out to be—that challenged me with the question: Why and how did a black manicurist from Chicago ever get a pilot's license in France?

I searched the file for clues. Born in 1892, Bessie was raised by a single mother in east Texas and educated in a one-room school for grades one through eight that closed whenever the cotton crop needed pickers. In 1915 she moved to Chicago. Almost 30 when she finally discovered her true vocation, she was refused lessons by every pilot she approached. But all this was merely bits and pieces of a tantalizing jigsaw puzzle. To find and fit together the missing pieces (most of them, anyway) would take the next three years.

"Bessie who?" I was first asked this question at the annual national Black Family Reunion Day, held in Washington, D.C., in the summer of 1991. I prowled the Mall that day, stopping

COURTESY ARTHUR W. FREEMAN

each group to ask anyone who looked old enough to qualify for Social Security if he or she had ever, as a child, heard older relatives or friends say anything about Bessie Coleman. Had they known anyone who had seen her, read about her, heard anything about her? Not a single person had. But when I told them the little I knew about Bessie, it invariably invoked an incredulous response followed by an eagerness to know more.

In May of 1991 we drove to the town of Bessie's childhood, Waxahachie, Texas. (I say "we" because on all my research trips outside of Washington—all by car—I was accompanied by my ever-helpful editor/agent/business manager husband.) If I were to envision Bessie the child, it seemed imperative to me to see the house where she was born and retrace the walk she must have taken to school every day. Aided by a tax receipt from her niece Marion Coleman in Chicago, along with various Ellis County assessors, surveyors, record keepers, and, ultimately, an aged black man who had known the Coleman family, we finally located the exact quarter-acre of land George Coleman had bought in 1894. The property, now overgrown with weeds and brush, was protected by a locked gate and barbed-wire fence with 12 inches' clearance between the red earth and the bottom wire.

Ignoring a NO TRESPASSING sign and crossing our fingers against snakes, we entered infantry style, sliding on our backs, noses barely clearing the rusty barbs. On land sloping down to a creek stood the sagging frame of a wooden house with nothing but empty space inside. It may or may not have been a remnant of the original Coleman home. But I was standing on Coleman land, and I could envision the rose bushes, vegetables, and fruit trees among which young Bessie had played and worked.

We were so absorbed in our investigation that when we turned to climb back up to the road, we were startled to see the revolving red and blue lights of a police car flashing against the sky. The officer just stood there, hands on hips, eyebrows raised. They lowered as we explained our motivation for breaking and entering, or at least entering. No, he had never heard of Bessie, but it was nice that she had come from Waxahachie. Yes, he knew about Amelia—his father had been an airline pilot—and he thought it very nice to meet her biographer.

The rest of the search for Bessie was far less embarrassing. I went back home to Washington and visited Howard University's Moorland-Spingarn Collection of African-American History, where I read every issue of the weekly *Chicago Defender*, which, during Bessie's career in the 1920s, claimed to be the black newspaper with the largest circulation. The paper had dubbed Bessie "Queen Bess," describing her flights in Chicago and interviewing her whenever she returned from giving flight exhibitions. When a *Defender* reporter asked her why she wanted to fly, she replied: "We must have aviators if we are to keep up with the times. I shall never be satisfied until we have men of the Race who can fly. Do you know you have never lived until you have flown?"

When Bessie was away from Chicago, however, she might as well not have existed. The *Defender* dedicated its news space to other matters of community interest: lynchings, demands for civil rights and better schools, political campaigns, church notices, and local crimes. Its advertising leaned heavily toward skin and hair care, automobiles, real estate, theater entertainment, trade schools, and clothing. Even without mention of Bessie, its pages were

On November 20, 1920, Coleman sailed to France, where she took flying lessons. The portrait above appeared on the license she received from the Fédération Aéronautique Internationale seven months later. A striking woman, Coleman (opposite) had no qualms about using her looks to charm the press.

Six years after Coleman's death in 1926, black pilots (whose ranks had increased) gathered at a Chicago armory to plan a ceremony in her honor (below).

NASM

invaluable for introducing me to the world in which she lived.

While reading the *Defender* microfilms, I began to receive answers to letters of inquiry I had sent out earlier. The International Women's Air and Space Museum in Centerville, Ohio, referred me to William Johnson, a black educator in New Jersey, who in turn gave me the address of genealogist Jean Albright Gilley, who lived in Atlanta, Texas, where Bessie was born. Gilley found for me the census records of the Coleman family and the address of her niece in Chicago. Marion had frequently stayed with her Aunt Bessie. She loved the beautiful, warm-hearted woman who paid the tuition for her Catholic nursery school, brought her woolen socks from Europe, modeled Paris gowns for her, and showed her the wigs that covered hair cut short for the wearing of an aviator's helmet. Along with Marion, Bessie kept at various times another niece, Vera Buntin, and two nephews, Dean Stallworth and Arthur Freeman; Freeman went on to become a mechanic at the famed Tuskegee Institute and, later, a licensed pilot. They were allowed to play her wind-up record machine while she cooked them dinner and gave them hugs and kisses and money for the movies.

Marion, now a 78-year-old retired postal worker, cherishes the time she spent with Bessie. "She was just an ordinary person," says Marion, "but just very ambitious. She sent me to ballet school. Even at an early age, I was doing more than most black kids would be doing at that time." Marion says that Bessie's mother, Susan, knew that her daughter was different when, even as a young child, Bessie vowed repeatedly to "amount to something."

Bessie almost never wrote letters (I came across only two in all my research). So while members of her family could fill me in on her personal life, they knew little about her life outside Chicago and her career in aviation. And I soon discovered that the white media, which had been of such major help to me while researching Amelia, was going to be no help at all with Bessie. White-owned newspapers in the 1920s wrote about African Americans only if they were entertainers or athletes or were involved in social protest or matters of sex, crime, or violence.

Should this characterization strike anyone as uncharitable, try the following story from the *New York Times*, dated May 24, 1925: " 'Can you Charleston?' is the question...by womenfolk seeking a cook...from the ranks of negro household workers.... For the Charleston is the rage both for ballroom and exhibition and, being of African origin, is naturally best known to darkies. Proprietors of employment agencies are being importuned to supply cooks, waitresses, laundresses and maids who can Charleston."

I began a journey totalling 11,000 miles in road trips and waded through what seemed even more miles of microfilm of African-American newspapers throughout the country. The material I was hunting often turned up in the unlikeliest of places. The *Pittsburgh Courier* was in the Rosenberg Library at Galveston, Texas. The *California Eagle* was in the New York Public Library's Schomberg Center for Research in Black Culture, as was the Baltimore *Afro-American,* which had run a glorious front-page picture of Bessie. Two years of the *Houston Informer,* from the site of some of Bessie's major stateside triumphs, had been stolen from the Houston Public Library but was finally found in the archives of the Wisconsin Historical Society. Closer to home, I uncovered the *Cleveland Gazette* in the Soper Library at Morgan State University in Baltimore.

While I envisioned Bessie the woman through the recollections of her family and friends, I found Bessie the flier and career woman in the pages of the African-American press. I learned of the legal troubles she had had with a black film company in 1923. After walking out on a movie being filmed in New York City because she considered the script demeaning to her race, Bessie moved to California, where she crashed in the first of the only two airplanes she ever owned. Though her injuries kept her in the hospital for nearly three months, Bessie's determination to "amount to something" never wavered. From her hospital bed, she sent this telegram to her friends and well-wishers: "TELL THEM ALL THAT AS SOON AS I CAN WALK I'M GOING TO FLY! AND MY FAITH IN AVIATION AND THE USE-

COURTESY MARION COLEMAN

FUL OF IT WILL SERVE IN FULFILLING THE DESTINY OF MY PEOPLE ISN'T SHAKEN AT ALL." What Bessie lacked in grammar she made up for in ambition; after she returned to Chicago, she found backing for a phenomenally successful exhibition tour of Texas in the summer of 1925.

Like Amelia, Bessie charmed the press whenever she had the opportunity to do so. Beautiful, articulate, and shrewd, she created a vivid public persona. She had a slim, shapely figure, and wore Paris gowns as elegant as the flying outfit she designed and had tailored in France: riding breeches, boots, and a tunic patterned after those worn by the Canadian Air Force. To endure the freezing cold of an open cockpit, she wore a long coat of soft leather but kept her goggles pushed up over her helmet until just before takeoff so that spectators could see her lovely face.

In Bessie's interviews with black newspapers I noted so many contradictions (over the years she always gave her age as 23) that even I began to doubt her, especially her claims of having met and flown with some of the most noted people in Europe and having attended the Caudron brothers' famous flying school at Le Crotoy in the Somme. Perhaps my lowest point came the day that my husband translated a letter I had just received from French aviation historian Marie-Josèphe de Beauregard, who reported that Bessie's name was

COURTESY ARTHUR W. FREEMAN

A crash in this Curtiss JN-4 put Coleman in the hospital for nearly three months, but she never considered leaving the dangerous profession she had chosen.

not on the list of the Caudron graduates of 1921. "Well," he remarked, "you've been looking for a title. How about *Bessie Coleman: Frequent Liar?*"

Fortunately my despair was not permanent. Three days before the final proofs of my manuscript were due at the printer's, a second letter from de Beauregard explained that her original list, obtained from an aged Caudron alumnus, was of military students only, and that Bessie's name was indeed on a list that included civilian graduates.

Though they didn't make the research any easier, Bessie's claims were no more wild and exaggerated than those made by most of her contemporaries—barnstormers who, like all entertainers, had to whip up free publicity any way they could. And Bessie was fighting for more than just airshow customers. In addition to proving that a black woman could be an expert and daring pilot, she planned to open an aviation school for African Americans so that no black aspirant would ever again be turned away.

Sadly, on April 30, 1926, fate got in the way. With a young white mechanic at the controls, Bessie's surplus Curtiss Jenny overturned while she was surveying the site for a parachute jump she had planned as part of an exhibition flight the next day in Jacksonville, Florida. Bessie fell out, somersaulting 500 feet to her death; the young mechanic, William D. Wills, died in the crash that followed.

Bessie's death resulted in banner headlines and editorials in black newspapers around the country, but it was virtually ignored by the white media. In Wharton, Texas, the white-owned *Spectator* did run a story headlined "Negro Aviatrix Killed in Florida Known Here," which concluded: "Many colored people here will note Bessie Coleman's passing with regretful interest."

In Jacksonville, however, both the *Florida Times-Union* and the *Jacksonville Journal* evinced something less than "regretful interest." Both splashed the story under big headlines. But it was Wills' death they mourned and reported, identifying Bessie only once by name in the lead and referring to her thereafter simply as "the Coleman woman" or sometimes just "the woman." The final indignity was delivered by the *Times-Union* in a follow-up story memorializing Wills as an industrious and likable young man and father of an infant daughter who had been killed "while instructing Bessie Coleman, negro aviatrix, in piloting an airplane."

White newspapers elsewhere generally ran either a three-paragraph story from the Associated Press or a one-paragraph item from the United Press. The *Chicago Daily Tribune* chose the UP story and failed to note anywhere that Bessie was a resident of Chicago. The *Orlando Star* also used the UP paragraph, without mentioning that in the two months before her death, Bessie had been living in Orlando, lecturing almost daily in the city's schools and churches about her dream that blacks would have a future in aviation.

Considering that she flew in a color-conscious era before television existed and when radio was still in its static-bound infancy, it's no surprise that a daring and clever woman who blazed trails for her race and gender died an unsung hero, largely unknown not only to whites but also to most blacks.

Now that the missing pieces of the Coleman puzzle are in place, I hope this amazing woman will finally be granted the recognition she deserves and that nobody will ever again have to ask "Bessie who?"

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PRACTICING SAFE SOFTWARE

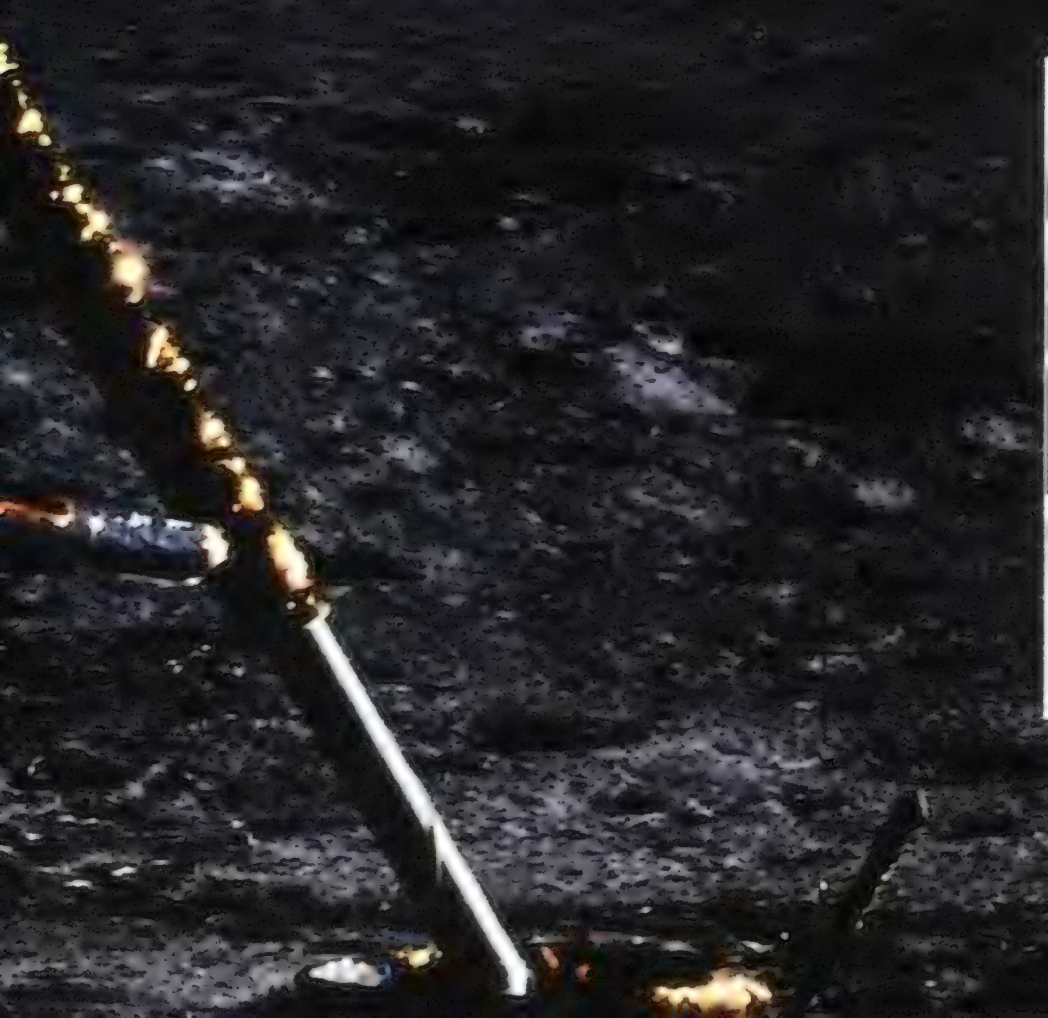
by Billy Goodman

From the Gemini and Apollo programs to today's space shuttle missions, computer programmers have learned to live with bugs.

The computer I used to write this article measures 8 inches by 11.5 inches by 2 inches. It weighs six pounds. Although already obsolete (it has only a 286 processor), it is faster and has more memory than the 70-pound computer on board the Apollo spacecraft that carried astronauts to the moon and back. Yet my computer cannot calculate a spacecraft's speed and heading, then calculate the small rocket burns necessary to change that trajectory; nor could it help the lunar module make a soft landing and then aid its rendezvous with the command and service module for the return to Earth. What does my computer lack? Software—the set of instructions that told the Apollo Guidance Computer how to do its job.

By the numbers, Apollo guidance and navigation software is not very impressive. It totals some 40,000 lines of computer code. A typical word processing program is many times larger. Xyquest's XyWrite 4.0, for example, runs 400,000 lines. What is impressive about the Apollo software is its reliability; lives depended on it at a time when computer programming was in its infancy. As Margaret Hamilton, who directed the programming of all Apollo onboard software at the Massachusetts Institute of Technology's Instrumentation Laboratory, put it in one of the almost daily memos she wrote during that time, "One of the main differences between the Apollo software and other software is that the former had to work the first time it was 'tested' in its real environment. There was no second chance."

By the time the space shuttle started flying in 1981, the techniques to keep software reliable had advanced. With the accelerated improvements in computer hardware that followed the introduction of the integrated circuit, programmers could rely more and more on the processor's memory and speed to automate communication between man and



NASA/JOHNSON; INSET, IBM

The Apollo 14 moon landing was made possible by a last-minute reprogramming of the lunar module's computers. The onboard computers were able to take advantage of integrated circuits. Mainframes of that era, like the IBM 7094 (inset), a NASA standard in the 1960s, still used discrete transistors.

machine. And building on the experiences of Apollo and other computer-intensive projects, programmers themselves grew wiser. Programmers have learned how software breaks, according to Robert Hinson, chief of the Shuttle Data Systems Branch at NASA's Johnson Space Center in Houston. And yet during a mission as recent as 1992, a space shuttle computer became stymied while executing a program it had run millions of times before. Programmers have also learned that bugs can hide, only to appear at the most inconvenient times.

The story of Apollo software reliability begins years before the first moonshot; one might trace it to a launch almost exactly seven years before the Apollo 11 landing, a launch remembered for one of the most spectacular bugs in space software. John Norton, a guidance software expert with TRW, watched the pre-dawn launch of the Mariner 1 space probe from Cape Canaveral on July 22, 1962, with his fingers crossed. As the guidance control officer for the Atlas booster rocket, he was responsible for the first five minutes or so of the flight, until the Atlas finished its job and separated from the Agena upper stage. At that point, Mariner would be on its way to Venus. But two errors doomed Mariner 1.

First, the guidance software contained a tiny bug. A symbol was missing from the guidance equations, part of the specifications that the programmer used to write the computer code. The missing symbol was a bar, which in mathematical notation signifies taking an average of the variable beneath the bar. The ground-based guidance computer needed averaged data in order to share the data between the two radar systems that guided the rocket. One of these systems failed during launch: the second error. The launch could have succeeded with just the remaining radar—except for the missing bar in the software. As a result of that omission, the computer processed the data incorrectly, saw erratic behavior where there was none, and, in trying to correct the "problem" (with telemetry to the rocket), caused true erratic behavior. And that's what the range safety officer noticed four and a half minutes into the flight, causing him to destroy the rocket.

The Mariner 1 bug has become the stuff of myth. Computer programming textbooks tell the story in introductory chapters as a cautionary tale. Norton did not write the code, but he had ultimate responsibility for approving it. As a result, he became the subject of

APOLLO SOFTWARE HAD TO WORK THE FIRST TIME IN ITS REAL ENVIRONMENT. THERE WAS NO SECOND CHANCE.

the second myth to come out of the Mariner incident. As Hamilton states the myth: "Norton took the crash very hard and devoted his life to finding errors in Apollo."

As with most myths, there is probably an element of truth to this one. Norton did carry a newspaper report of the accident in his wallet for years, and the incident could have ratcheted his already legendary vigilance. Barry Boehm, a former chief engineer and colleague of Norton's at TRW, where Norton is still a senior software engineer, says programmers there coined the term "Nortonize." "If your design had been 'Nortonized,' " says Boehm, "you had a significantly higher level of confidence that it would work."

"Mariner was several years before Mercury, and that was the scary part," says Norton today. "We fully realized we could not guarantee perfection." But he worked to get the Apollo flight software as nearly perfect as it could be. He was hired by NASA to examine the code for anything wrong or inconsistent or just plain unusual.

For example, the astronauts wanted displays in feet per second, but most calculations used meters per second; Norton checked the conversions. Or when a program was converting angles around a circle to units called radians, the programmers used 22/7 as the value of pi, which, while not wrong, is not as accurate as the decimal approximation, 3.14159.

Most significantly, Norton double-checked the program line by line, translating it into the guidance equations the code was directing the computer to solve. The results of this *un*automated computing Norton calls "programmed equations."

The program that Norton annotated was written in assembly language, each line a cryptic, hard-to-read instruction only barely removed from machine code—the 0's and 1's computers understand. "It's very difficult to pick up an assembly language listing—no matter how well annotated—and figure out what was going on," says John Garman, one of the computer experts at mission control during Apollo. Garman says Norton's documentation was "almost a handbook for the onboard software," and the distribution list for the programmed equations grew from 33 to 198 copies.

By writing out the equations, Norton studied what the computer was being asked to do. "Programmed equations," he says, "was the difference between riding in the car as a passenger and driving for yourself. By driving yourself, you have to pay attention to all the details."

"Norton found more errors by scanning than all the errors found by testing," says Hamilton. He was so fast and so thorough that Hamilton and others at MIT and NASA, most of whom had no contact with him beyond his memos, formed a picture of Norton working late, subsisting on TV dinners, and churning out programmed equations overnight: fast, precise, computer-like. Even today's chief software luminary, Microsoft's Bill Gates, recalls that as a senior in high school, he idolized Norton. "He was a god!" Gates told the authors of the book *Gates*. "He would take a piece of source code home, come back and just totally analyze the thing. Just a high-IQ act."

But even with a secret weapon like Norton, MIT's instrumentation lab subjected Apollo software to "endless testing," in the words of Garman, who is still at NASA's Johnson Space Center. Onboard software went through six levels of testing before it ever left MIT. First, small modules of code that performed just a single algorithm were tested to make sure they were computationally correct. Each subsequent level of testing checked the code at in-

creasing levels of integration to verify that separate modules worked together, passed data back and forth, and shared the computer's tiny erasable memory correctly.

The resulting Apollo software exhibited a feature that, though common today, was innovative for its time and contributed to its robustness in the face of uncertainty. As an engineer would put it, the software was asynchronous and priority-driven. That means that if it is running one task and another with a higher priority comes along, the computer saves the interim results of the lower-priority job and starts the more important one. When finished with the high-priority task, the computer picks up where it had left off. That contrasts with the then-more-common "boxcar" approach, in which tasks are carried out in a specific order, one after another, with each cycle repeated until finished. The main safeguard of Apollo's priority-driven system was that the computer could not be prevented from performing a critical function by getting hung up on a potentially unsolvable problem; it would be less likely to get caught in a loop, in other words. The Apollo computer had 20 milliseconds to complete a cycle. At the end of that period, the computer would begin again with the highest priority functions.

At the Manned Spacecraft Center (now the Johnson center), the software was put through its final test in "integrated simulations" involving the astronauts and the flight controllers. "In running these simulations, which tied mission control to the crew chamber, people played like it was real, but the failures were faked," says Garman. He and the simulation instructors cooked up some failures involving computer bugs. On the last integrated simulation, 11 days before the launch of Apollo 11, a program alarm went off during the descent of the lunar module. Steve Bales was the controller in charge of guidance for the LM, and he had no idea what the alarm meant. He called an abort, with the LM 10,000 feet above the lunar surface. "I had a hard time explaining my actions" after the simulation, Bales says. "Something was going on we didn't understand, so I thought we should abort." The program alarms were in part debugging aids, useful to programmers as they developed the programs; they were built in to let a programmer know that the computer was overloaded, unable to finish all the tasks in its execution frame. Mission planners never expected them in real time.

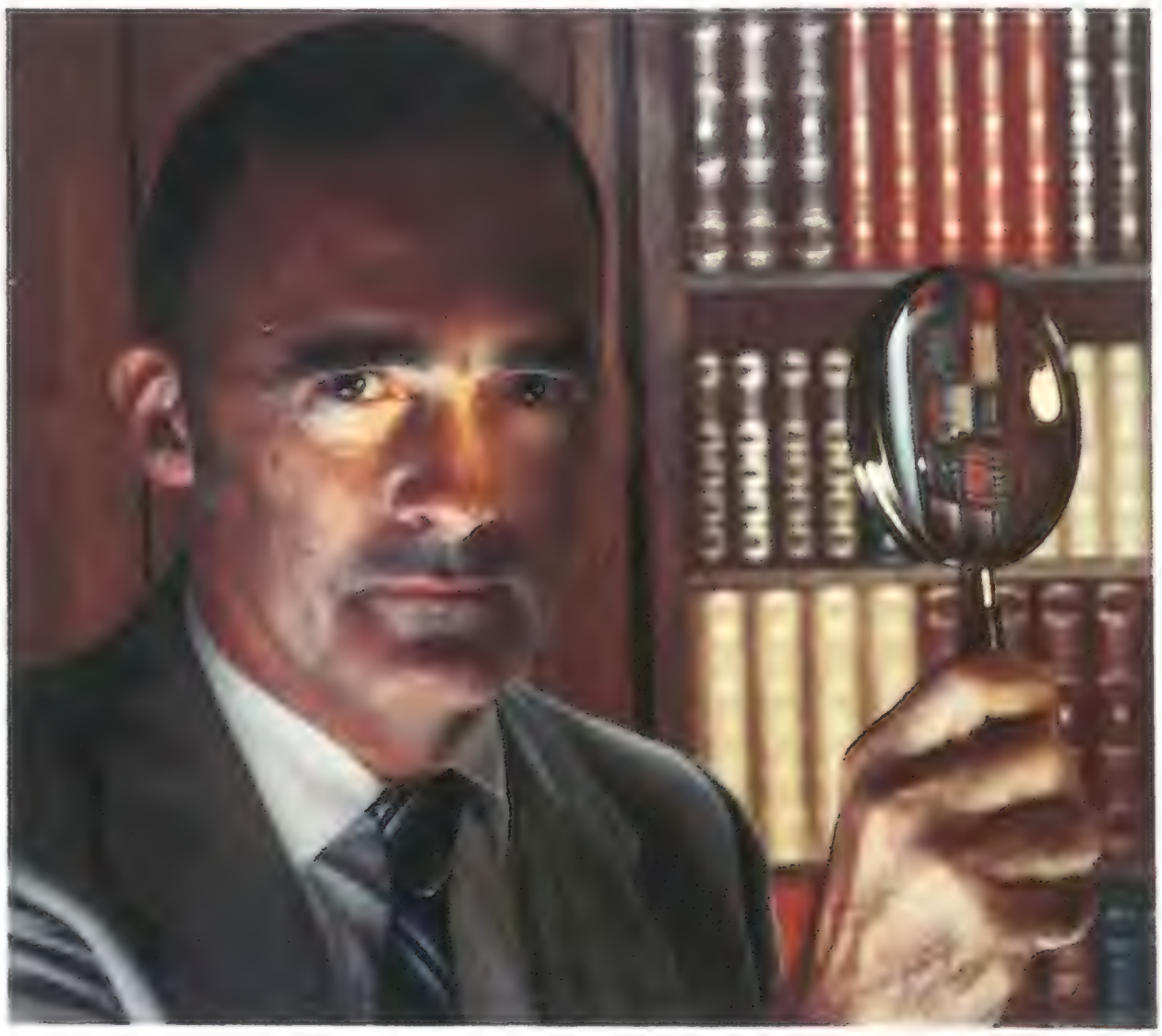
After the aborted simulation, flight director Gene Kranz assembled the controllers, Garman remembers, and told them to develop a response for every program alarm. There were about 40 alarms. "Most were innocuous," Bales says, "but about 10 were in a class requiring judgment." For these, Garman says, "the notes we wrote were to the effect that if the alarm doesn't happen too often and nothing else seems wrong, then the best thing is to just proceed."

As it happens, Bales was the guidance controller on duty for Apollo 11's landing on the moon. Exactly 316 seconds into the descent, Buzz Aldrin reported a "1202" program alarm, one of those requiring judgment. Forty seconds later the alarm repeated.

"That was a shock to our system," says Bales. "We had 10 to 15 seconds to decide what to do. I remember Jack [Garman] talking in my ear, saying 'It's not coming too fast, it's the same type we had before.' " Bales called "Go" to the flight director. The alarms recurred three more times before the landing. Because of this distraction (and because they had to fly past the landing site, which was strewn with boulders), the astronauts lost track of where they were, and it took mission control a few hours to pinpoint their location.

It took even longer to determine why the alarms occurred, but the source turned out to be extraneous data from the rendezvous radar. The radar had no role to play in the landing but would be used by the LM after takeoff from the moon for return to the command module. Initial mission procedures called for the radar to be shut off during the landing, but at the last minute it was decided to leave the radar on in case the landing was aborted and it was needed. What mission planners didn't realize was that while the LM computer was busy carrying out the tasks necessary for landing, it was also process-

John Norton proved to be the toughest test of Apollo software. One colleague referred to his notes as "Nortran."



ing data from the rendezvous radar.

"The computer was interrupting itself hundreds of times a second, adding and subtracting bits from memory," says Garman. "Just the act of doing that addition and subtraction stole 15 percent of the computer's available time." Carrying out the tasks necessary for landing took about 85 percent of the computer's available time, so the added work sometimes pushed the computer to the end of the cycle before all tasks were completed, triggering the alarms.

"Had the radar noise problem taken 20 percent of the computer's time, it's not clear we could have landed," says Garman.

"Our software saved the mission," Hamilton says, "because it was asynchronous—it bumped low-priority tasks. Without it, the mission would have aborted or crashed on the moon."

Software and a quick-thinking programmer also saved the lunar landing of Apollo 14. In the lunar module Antares, Alan Shepard and Edgar Mitchell were on their 13th revolution of the moon, preparing for their powered descent to the surface. Back at mission control, flight controllers monitoring Antares' instruments received a jolt: intermittent abort signals from the LM. It was as if one of the two abort buttons had been pushed, though of course it hadn't. Although the buttons had no effect during the lunar orbit phase, as soon as powered descent began, an abort signal would cause the computer to activate the ascent engines and begin other steps to facilitate a rendezvous with the command module. An abort signal, in other words, would end the mission.

Alerted to the difficulty, Mitchell opted for what frustrated homeowners confronted with balky electronics always try first: he tapped the instrument panel with his penlight. The abort light went off. When the light came on several more times, Mitchell again tapped the panel, each time with the same effect, indicating to him "that we had a foreign object, probably a solder ball, floating around in the switch" and causing intermittent short circuits.

Two hundred forty thousand miles away, Don Eyles, the man who had written the program for the lunar landing, was in his office at MIT's instrumentation lab. It was after midnight, but it was customary for contractor personnel to be on call during missions, and Eyles' software was on the line. The hardware was at fault, but successful continuation of the mission would depend on software. Notified of the faulty abort signal, Eyles grabbed the program code. "My first reaction was that it wasn't so serious," he remembers. "But when the signal repeated, I thought there might be no good way around it. Then I looked at the code and it became an ingenuity thing, a problem to solve. I saw it as my responsibility—it was my code. If anyone was going to see a way around it, it was me."

By all accounts, Eyles was the right person for the job. Fellow programmers describe him as very bright and creative and, more importantly in this situation, able to think on his feet. The problem he faced was that as soon as the LM began powered descent, the computer would begin monitoring the abort switch several times a second and would stop the landing if it detected the abort signal.

One solution immediately presented itself: turn the monitor off so that the computer would not detect an abort request. The abort monitor is controlled by a single binary digit in a 15-bit flagword. That bit controls the state of the monitor—1 means the monitor is enabled, 0 means disabled. At the ignition of the descent engines, the bit is set to 1; to disable it would require that Mitchell key in software commands. But Mitchell would have to wait until the monitor was turned on at ignition to key in the work-around. That was deemed unjustifiably risky: If the random abort signal surfaced during the time that Mitchell was punching the keys, the mission would abort.

> IF THE SIGNAL SURFACED WHILE MITCHELL WAS PUNCHING THE KEYS, THE MISSION WOULD ABORT.

Eyles had to figure out a way to disable the abort monitor so that it had no period of sensitivity during which the random signal would cause an abort. And he had to work fast. Antares would make an extra orbit of the moon, lasting less than two hours, but further delays would jeopardize the mission.

As Eyles told me this story in a small conference room at the Draper Laboratory (formerly the Instrumentation Laboratory), where he now works on software for the space station, the voices of shuttle astronauts and mission controllers could be heard in the background, piped in so that laboratory personnel can monitor a mission if necessary. Eyles opened the bound volume of the Apollo software listing to the page that contained the abort monitor—code he wrote more than 20 years ago. The entire routine took only 24 lines of assembly language code.

"I saw that the monitor would not function once it saw that an abort had been called for," Eyles says. "So I designed a procedure to set an indicator—called the mode register—to read as if the abort program were under way, so that the monitor would no longer check the state of the abort switch." After all, why continue to check for the abort signal after an abort has commenced? In the short time he had, Eyles wrote the workaround, ran it on a simulator at MIT to see if it worked (the first attempt didn't), and read it to mission control for more tests. Eyles says he did not feel an unusual amount of pressure. "It was one of those adrenaline moments," he says when pressed.

When the LM came around the moon, with about 15 minutes before the engine burn to begin powered descent, the capsule communicator read the procedure to Mitchell, who keyed it in. The fix worked flawlessly.

Apollo, with its single computer, followed a philosophy of attempting recovery from any failure. The space shuttle borrowed some of Apollo's mechanisms of fault tolerance but added others. First, there are four identical guidance and navigation computers on the shuttle, to guard against hardware failures. If one computer gives a solution that differs from the rest of the pack, the astronauts assume a failure and turn it off. Second, there is a backup—a fifth computer running independent software capable of managing ascent, abort,

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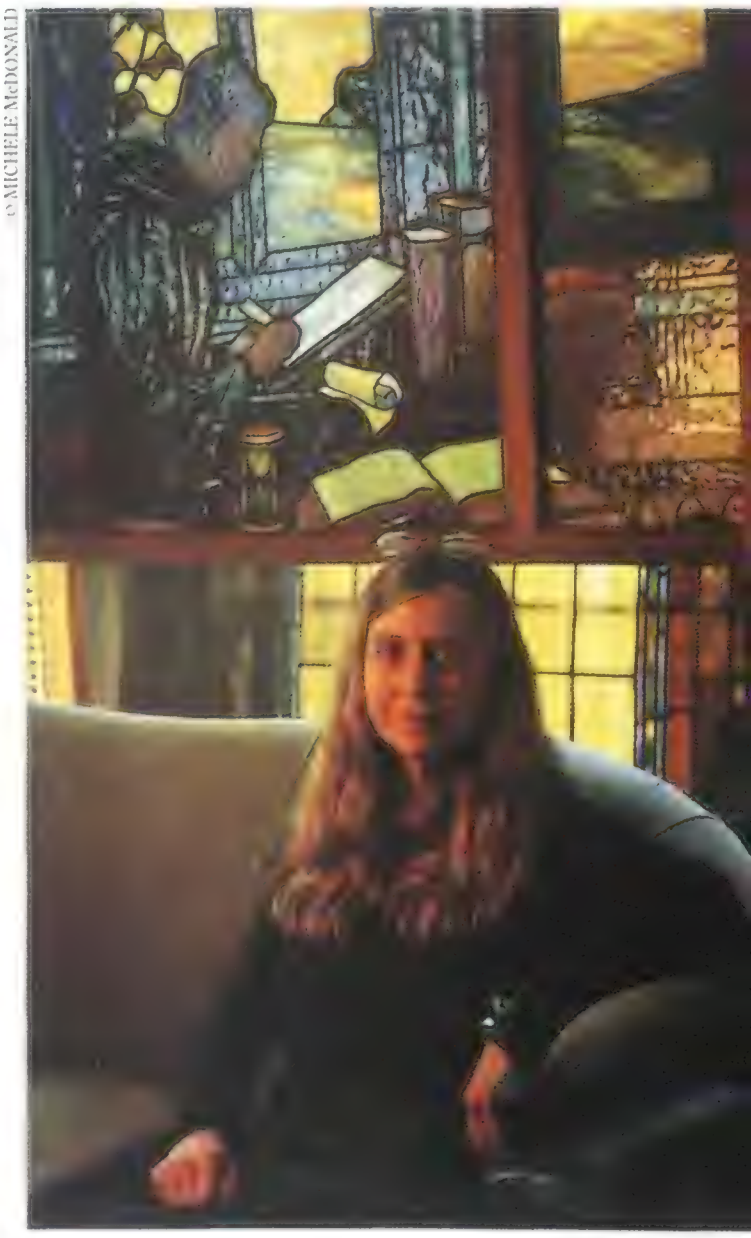
John Garman presides over the mainframe system that supports the maintenance of shuttle flight software.

Margaret Hamilton argued for priority-driven software for Apollo, the feature that saved the Apollo 11 mission.



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and reentry. The backup protects against a software bug affecting the four primary computers.

To simplify the task of writing and revising software for the space shuttle, NASA hired Intermetrics, a Boston company, to create a high-order language, HAL/S (only coincidentally similar to the name of the homicidal computer in *2001*). Another program, a compiler, translates HAL/S into machine code for the computer to execute (see "Nothing's Lost in the Translation," p. 66).

To inspect the software, engineers no longer scan lists of assembly commands that perform the same function as pushing the buttons on a calculator. Instead they read expressions based on the logic of the English language and can recognize mistakes and inconsistencies more easily. "The code isn't as tight," says John Garman. "The programs run slower and take up more space. But the advent of faster computers with more memory made the use of high-order languages possible.

"That's one of the reasons word processing software is so rich and user-friendly. It runs slow and takes up tons of memory. But if you want to change the heading or the margins on a document, you make one change instead of one for each page."

Teams of programmers still inspect the software in discrete stages against a checklist carved in stone: first to make sure it is asking the computer to perform the calculations that the programmers want it to perform, then to make sure that data the computer retrieves from other sources for the calculations are current, and so on.

"We realize people are human and humans are going to make mistakes," says a former IBM manager responsible for shuttle software development and maintenance. Today Loral Corporation has that contract. "You have to design a process that looks for mistakes it assumes are there. You have to put enough eyes and people to prevent single-source failures. The chance of six people looking at the same code and missing an error are much less than one person missing the error."

Add layers of simulations to the inspections and it's hard to understand how errors creep through. "Errors of rare occurrence—those are the ones that drive you crazy," says Dan Lickly, one of the key members of MIT's instrumentation lab during Apollo days. "You may simulate thousands of times and not hit the error." A rare one surfaced during *Endeavour*'s 1992 mission to rescue Intelsat VI (see "Reality Check," Oct./Nov. 1993).

In preparation for the rendezvous, the shuttle computers were calculating when and how long the rockets of the Orbital Maneuvering System should fire. The procedure is for the computer to calculate the burn several times before the actual firing. As the shuttle gets closer in time and space to the satellite, the calculations will be more accurate.

For each targeting calculation, the computer runs 10 iterations of the equations to find the answer that will put the shuttle within the desired distance of its target. Software designers built in a limit to the number of iterations, however, to avoid an infinite loop. If the desired distance isn't computed within 10 iterations, the computer reports that it "failed to converge," precisely the mes-

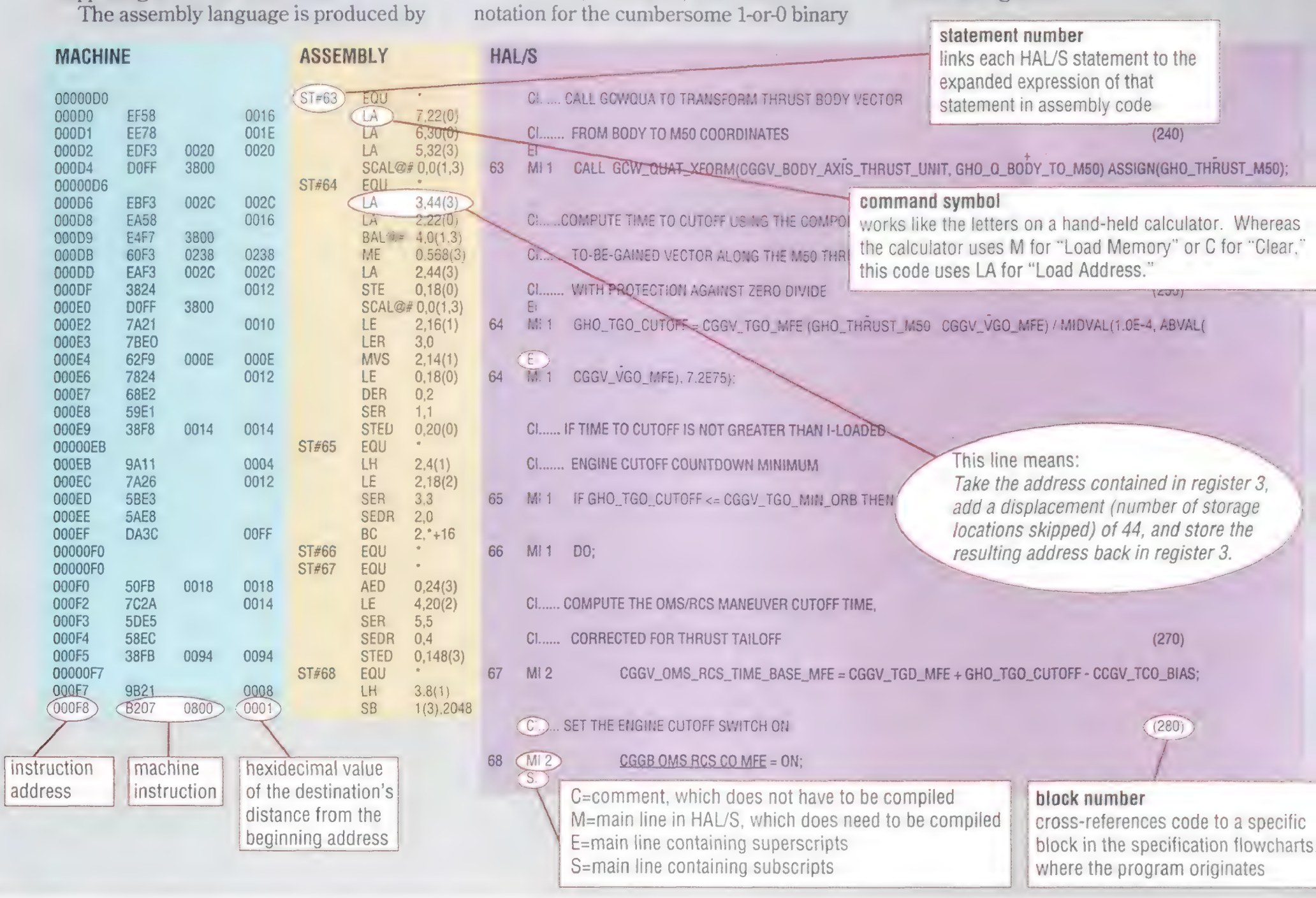
Nothing's Lost in the Translation

A small segment of code used to calculate the duration of an Orbital Maneuvering System burn (opposite) appears here in three languages: machine, assembly, and HAL/S. Notice that many HAL/S commands—DO, CALL, IF...THEN—are recognizable by any English-speaking person. HAL/S also includes commentary—the lines marked "C"—to help programmers understand what's happening in the list of commands.

The assembly language is produced by a compiler, a program that breaks HAL/S instructions down into the expanded list of operations that the computer must perform. Statement #65 in HAL/S, for example, tells the computer that if the time to engine cutoff is smaller than or equal to a certain value, then it should move on to the next instruction. Statement #65 in the assembly code is followed by five distinct operations that the computer must accomplish in order to make the comparison directed by HAL/S.

The machine code is expressed in hexidecimal, or base 16, a shorthand notation for the cumbersome 1-or-0 binary (base 2) system in which the computer operates. Hexidecimal is chosen because 16 is a power of 2, making conversion from one base to the other easy. One hexidecimal digit—numerals 0 through 9, then letters A through F—can stand for four binary digits.

The assembly and machine codes pay more attention to the computer's internal map than HAL/S; that is, they ask for data to be retrieved from and stored in specific locations within the system memory and processed in temporary holding pens, known as registers.



sage that Commander Dan Brandenstein received before one of the burns in his attempt to rendezvous. NASA took an extra orbit to sort things out and eventually used a solution calculated by a ground computer.

NASA's Robert Hinson says the genesis of this problem dates to the early 1970s, when programmers were writing code for computers with only 60K of memory. (By the time the shuttle flew, the computers' memory had increased to 106K. It has since been upgraded to 256K.) As a result of this ceiling, the intermediate results of some calculations could be stored with only limited precision—up to seven significant numbers, for example, instead of 14, double precision. You have a similarly limited accuracy in the number of places that can appear in the window of your hand-held calculator. Computer experts agreed that some results would require double precision and that the calculations for rendezvous should be programmed to use some of each.

Although mixed-mode arithmetic had not been a problem on any previous rendezvous—indeed, the routine was thought to be sufficient for all sets of

numbers—the specific set of mixed-mode numbers that the computer tried to crunch in this instance made it want to keep trying. A number of calculations comparing where the shuttle wanted to be with where it could be by executing a certain burn looked equal. Part of the calculation thought the computer had converged. The other part thought it should keep trying. The numbers were so uniquely close together that the algorithm broke down.

It was such a rare situation that NASA did not require IBM to rush to fix it but waited until the next major computer program release, completed in 1993. For that release, programmers changed the entire set of those calculations to accept all double precision numbers.

Not every error discovered in the software is corrected by changing the code. According to John Garman, it's safer not to fix certain "benign anomalies" once they've been discovered, since "you generally introduce a bug for every few you correct." For this reason, on every shuttle mission the astronauts fly with a set of footnotes to the software, describing various bugs and how to work around them.

These are the bugs they know about. Since the shuttle resumed operations in 1988 following the *Challenger* accident, only one error that was the result of a coding deficiency slipped through. The crew didn't notice it during the flight, but analysts at NASA found it by studying the telemetry afterward. It was a benign error; a notice to the crew appeared twice instead of once on their computer screens. But it rattled the programmers. They knew that any error could be dangerous. That this one was insignificant was a matter of luck.

The exhaustive process of scanning code for errors, testing, and simulating continues as the shuttles are fitted with new altimeters and cockpit instruments, upgraded to automatically integrate navigation information from the Global Positioning System, and adapted to dock with the Russian space station Mir. Almost every hardware change requires a software change, and for every software change there are dozens of ways that the comp0ter1 c0uld s#5dc e4101000lej xuhy2 18&89j4.

NASA/JOHNSON (2)

The Unfriendly Skies

If you're flying on a Russian airline you'd better fasten your seat belt. It could be a bumpy ride.

by Bill Thomas

Photographs by Klaus Reisinger/ Blackstar

When I called a friend of mine in Moscow and told him that I planned to test fly Aeroflot to see how the airline has changed, he made a noise like a bomb falling. "Aren't you afraid?" he asked.

Afraid? Well, not at the time. But it didn't take long to get mad.

After I had boarded a Washington-to-Moscow flight last winter, departure was delayed for over two hours with no explanation and no heat. As in the old days, all inquiries were greeted with minimal eye contact and identical shrugs from crew members.

But in a surprise move shortly after takeoff, the cabin staff made amends by serving free vodka followed by *three* consecutive steak dinners. *There's one improvement*, I thought. On my last Aeroflot trip, a flight to then-Soviet Georgia in 1991, the meal consisted of greasy bread and lukewarm mineral water.

While the world questions the safety of Russian commercial aviation, Aeroflot airliners undergo overhaul at Moscow's Shermeteyavo-1 airport. Some Russian airlines, including Aeroflot, are turning to Western aircraft and engines (above).

On the old Aeroflot, the customer was always wrong, particularly if he had booked a seat the crew had reserved for the TV sets and VCRs they were bringing home from abroad. Now you get the seat you pay for, and the eagerness to please is likely to catch some veteran passengers completely off guard. "Excuse me, sir," a stewardess said, politely waking me up a few hours before landing, "would you like to buy a duty-free watch?"

Welcome to the schizophrenic skies of Russia's "new" carrier, Aeroflot-Russian International Airlines.

"We're trying to change our image," says Victor Novosselov, general director of Aeroflot's Washington, D.C. office, admitting the effort has been impeded somewhat by politics in Moscow. The hammer-and-sickle that still adorns many of Aeroflot's airplanes will go, Novosselov says, as soon as company officials can agree on a new symbol. But with a management system largely inspired by Five Year Plans and plagued by bureaucratic inertia, removing other signs of Aeroflot's Soviet past may be more difficult.

Like most things in the former Soviet Union, Aeroflot is being "restructured." If the deregulation of America's commercial aviation industry seemed complicated, picture the dismantling of a single government-run airline that once employed 400,000 people and had a fleet of 11,000 airplanes and helicopters. Trimmed down to a fraction of its former size, the once-giant carrier now flies only to international destinations. In the scramble to fill its vacated airspace, up to 300 newly created airlines have taken over its domestic routes, and a dozen others vie with Aeroflot's depleted fleet for overseas business. The resulting chaos is hard to imagine even by Russian standards. Mechanical breakdowns and fuel shortages regularly ground dozens of flights every day, and crashes have become so common that Muscovites jokingly call them "unscheduled descents."

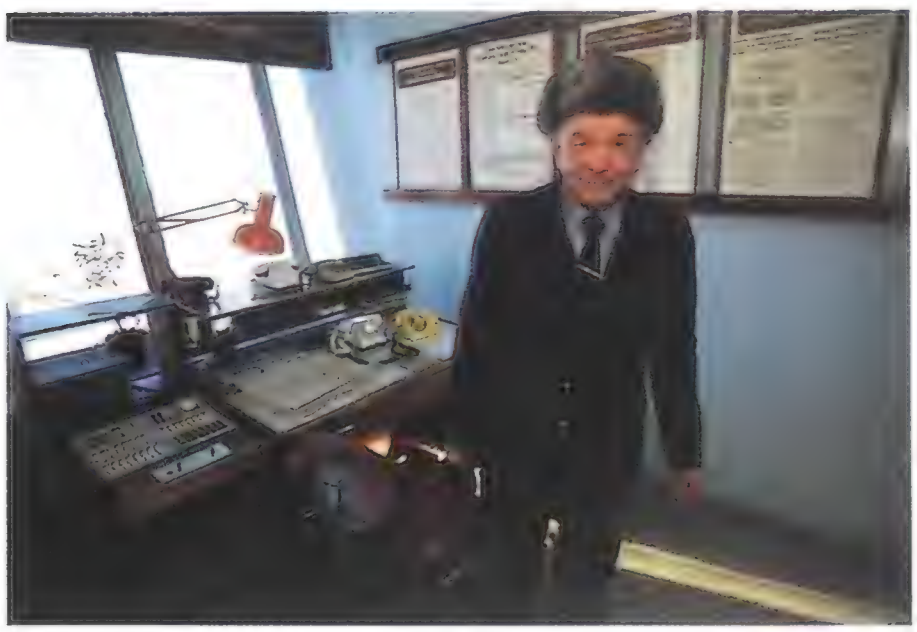
The most bizarre in a series of recent disasters took place last March, when an Aeroflot A310 bound from Moscow to Hong Kong took an abrupt nose dive in Siberia. All 75 passengers and crew were killed. According to investigators, the Airbus crashed after the pilot had turned over the controls to his 15-year-old son. "How could this have happened?" demanded one Moscow newspaper. "What passengers must ask themselves as they buy an Aeroflot ticket is who will be flying the plane."

Many, needless to say, are doing just that. But thanks to the free-for-all now going on in Russian aviation, the answer is anyone's guess.

At its peak, Aeroflot made regular stops in all 11 Soviet time zones, as well as New York, Tokyo, Paris, and such ideological outposts as Vietnam, Cuba, and North Korea. Though some of its flights were little more than airborne propaganda missions, Aeroflot still flew more airplanes and more passenger miles than any other airline in the world.

In terms of sheer versatility, "Aeroflot

One of the workhorses of domestic Russian aviation is the Antonov An-2. A shed provides the mechanics at Khadarovsk airport a little shelter.



Winter temperatures on Sakhalin Island can fall to -45 degrees, and aircraft are de-iced with fishing nets dragged across the wings (left). In such conditions, pilots must also deal with frost-coated windscreens (below). Russia's more remote facilities, like the control tower at Khadarovsk's secondary airport (below left) remain relatively primitive.

did its job superbly," wrote airline historian and National Air and Space Museum curator R.E.G. Davies. It delivered Party secretaries to summit conferences. It performed crop dusting chores in the Soviet Far East. And whenever the KGB wanted to relocate political dissidents, it was Aeroflot that whisked them away to internal exile.

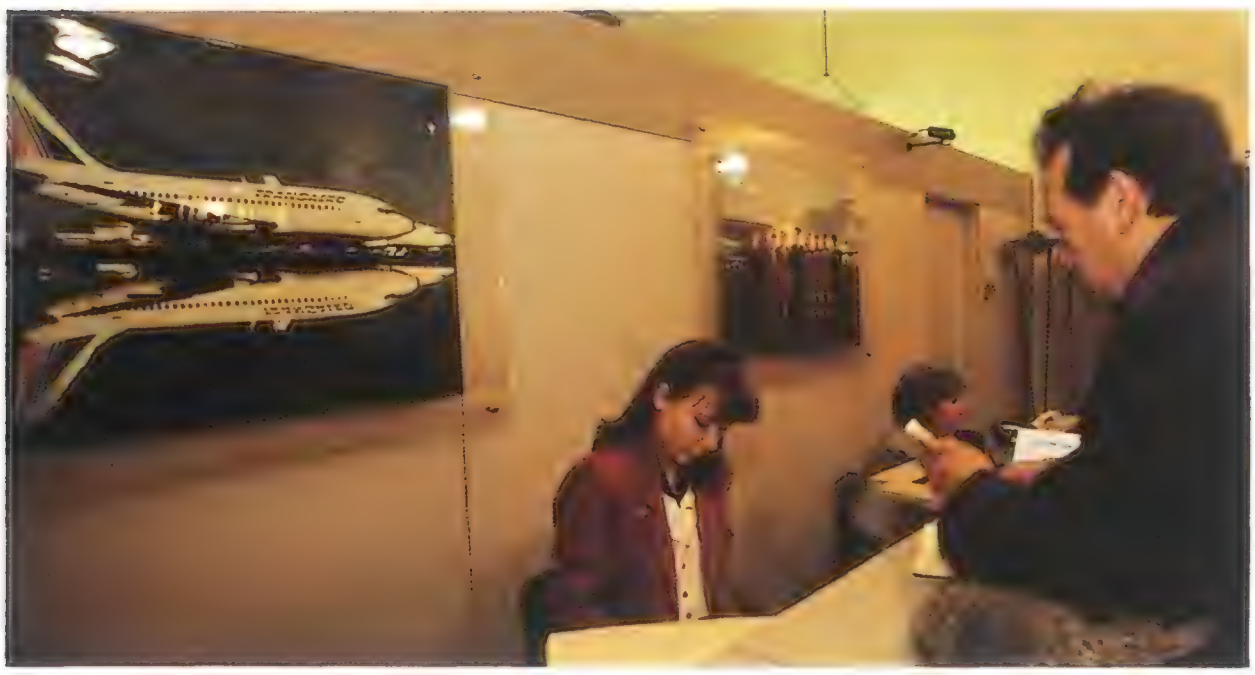
But after the Soviet Union dropped off the radar screen of history in 1991, Aeroflot underwent its own version of *perestroika*. Following a series of decrees de-Sovietizing the airline, most of its airplanes were appropriated, in classic Russian style, by anyone in a position to take them. Regional airports throughout Russia declared themselves private companies, often seizing whatever airplanes happened to be parked on their property. At some facilities, private ownership is merely an academic exercise, since fuel shortages and equipment failures have brought service to a virtual standstill. At others, business is booming as mafia gangs have moved in, coercing pilots and converting terminals into depots for all sorts of smuggling activities. In the former republics, Aeroflot aircraft and equipment were nationalized to form new state companies, like Turkmenavia, the official airline of oil-rich Turkmenistan, and Air Ukraine, the flag carrier of a country on the verge of bankruptcy. In Moscow alone, some 20 passenger and cargo carriers have been started from Aeroflot leftovers.

One of those companies, Vnukovo Airlines, began operations at Moscow's Vnukovo airport in May 1993 with 58 airplanes and 3,000 employees. Like many new Russian airlines, Vnukovo is partially stockholder-owned, with shares distributed by the Kremlin ministry in charge of privatizing former state industries. But in a familiar scenario, high operating costs, the effect of hyper-inflation on stock sales, and mechanical problems have kept many of the company's aircraft out of service and Vnukovo executives searching for hard-to-find foreign investors.

"I don't see how all these airlines can survive," said Boris Alekseev, president of the CIS-USA Council for Trade and Economic Cooperation. Alekseev predicted that Russia's smaller airlines will have to merge with larger ones, or simply go out of business. "I think you'll see far fewer companies five years from now than you see now," he said. "It's one thing to say you're an airline, and another to perform like one."

At Aeroflot headquarters in Moscow, located in the back half of a joint-venture hotel, the corporate mood was almost as bleak as the late-winter weather. "We have many new ideas, but we can't implement them until we become more independent," complained Serguei Franstev, Aeroflot's executive director for international activities. "When we get more freedom, we will be able to do some of the things that other airlines do."

Other airlines, though, don't have Aeroflot's burdensome legacy of state control. For over 60 years, "Aeroflot" was another name for the Soviet Civil Aviation Ministry. It was only in 1993 that the United States officially recognized the airline as a business. Before that, Aeroflot was classified as a foreign mission of the Soviet government. The problem is that the same people who were in charge during the previous



New business opportunities have emerged in the wake of Aeroflot's restructuring. Using one of the airline's Mil-8 helicopters, Frenchman Eric Vercesi has started a champagne-and-caviar charter service in Khadarovsk that caters to Japanese tourists (top). In Moscow, passengers buy tickets for Transaero, the first airline to compete with Aeroflot (above). Georgian art dealer Nana Shavgulidze (right) started her own luxury airline, Shans, with a single airplane.

regime are still running things just as they did in the days of central planning.

Under the Communists, information about Aeroflot's operations was a closely held state secret. Foreigners could be arrested for so much as photographing an airplane. Trying to find out anything in Russia can still be a difficult task. It can take weeks to penetrate the airline's multi-layered bureaucracy, and even then there's no guarantee of locating the person in charge.

Higher-ups in any Russian organization disappear without warning. When I was in Moscow I found that one top Aeroflot executive had suddenly departed for a rest at a health spa, leaving the marketing department in disarray. "He told me to tell you he'd be back in a month," said his assistant. Another official was on vacation, then he was ill, then he was back on vacation again. And of course no one important will ever talk on the phone, fearing, with reason, that the line might be bugged.

Nevertheless, some facts about Aeroflot have become easier to find. The airline has started publishing a glossy four-color annual report full of interesting statistics. The 1992 edition (the latest available) claims, among other things, that during that year the company flew three million international passengers

on 45,318 flights for an after-tax profit of about $120 million.

There's no question that eliminating its Russian routes helped Aeroflot's bottom line. Political problems and rising ticket prices have sharply reduced passenger traffic inside Russia. According to the Russian Department of Air Transport, the number of domestic air passengers fell from 60 million in 1992 to 40 million the following year. For the same period, Aeroflot reports that its passenger volume and profits both rose by nearly 20 percent.

Reduced to 110 airplanes and 17,500 employees, Aeroflot anticipates the Russian Federation will eventually scale back its ownership to 51 percent of the company's stock, with 49 percent to be held privately. "After a few years, we'll see if it will remain a state carrier or be further privatized," said Gennady Yegorov, general manager for Aeroflot in Switzerland. Yet to be decided is whether stock earmarked for private ownership will be split up or sold as a single block.

Meanwhile, Aeroflot officials acknowledge they have a lot to learn about doing business on their own. "You have

to remember that making money used to be against the law in this country," said Anatoly Brylov, Aeroflot's deputy executive director and chief legal advisor. "We've had to adapt to a whole new set of rules."

One of those involves ending the company's longstanding policy of secrecy in reporting accidents. Aeroflot's uncharacteristically quick release of data blaming last spring's Airbus disaster on pilot error was widely seen as a step in the right direction, although one that could lead to international sanctions and millions of dollars in claims being assessed against the airline.

Sometimes Aeroflot gets blamed for other carriers' crashes. Last winter a Tu-154 owned by the newly formed Baikal exploded after takeoff in southeastern Siberia, killing 125 people. Most press accounts identified the aircraft as belonging to Aeroflot. The mistake was understandable, since the jet, like hundreds of others throughout the country, had never been repainted to show its new ownership.

In the Soviet Union, air travel was never considered the sort of upper-class luxury it was in Europe and America. From its inception, Aeroflot was a no-frills state utility, more like a government-subsidized Greyhound than a Pan Am or TWA. It wasn't until the airline began flying to the West in the 1950s that it introduced first class accommodations. Unfortunately, most Russians, who have never flown to the West, are familiar with only one type of treatment from Aeroflot, and it definitely isn't first class.

Russia is now in the midst of its first-ever consumer revolution. Years of pent-up frustration have made the public clamor for everything money can buy, even if its currency borders on worthless. Aeroflot has responded with a pledge to improve customer service. But after decades of being treated like excess baggage, few Russians believe it will happen.

Some of the new airlines hope to capitalize on consumer dissatisfaction. One of them is Shans, a "deluxe airline" that operates three flights a week from Moscow to Tblisi, Georgia. Begun by Nana Shavgulidze, a Georgian art dealer and the only female airline president in the former Soviet Union, Shans consists of a single Tu-154 leased from a subsidiary of Aeroflot. "I wanted Shans to be everything Aeroflot wasn't," said Shavgulidze, "so the first thing we did was take out the 160 Aeroflot seats and put only 60 of them back in. My philosophy is more leg room."

Transaero, a three-year-old carrier based in Moscow, also offers Western-style service and aircraft, with a mini-fleet built around two leased Boeing 737s and three 757s. The first challenger to Aeroflot's lock on the Russian market, Transaero was an immediate hit, making profits in all three years of its existence. In 1992, Transaero flew 53,145 passengers to eight regularly scheduled destinations outside of Russia, among them Istanbul, Kiev, and Shardjah in the Arab Emirates, a favorite stop for Russians looking to buy cut-rate Japanese electronic equipment for "re-export" to Moscow and other cities. Transaero, which features flight attendants trained by Air France, advance round-trip booking, and the first Russian frequent flier program (fly 10 times, get one trip free), takes full advantage of Aeroflot's well-known reputation for discomfort. "Forget all your pre-conceptions about the glamour of air travel," says one Transaero ad. "Taking a flight on Aeroflot can be a real down-to-earth experience. Close your eyes and you can almost imagine you're riding on a bus."

"We treat our passengers with respect," said Serguei Grachev, Transaero's marketing director. The effort has clearly paid off. The demand for tickets is so high travelers sometimes have to wait weeks for a seat.

In order to keep pace, Aeroflot has upgraded its collection of Soviet-era relics with two new Ilyushin 96-Ms, powered by Pratt & Whitney 2000-series engines and outfitted with Rockwell Collins Avionics. It has also leased five Airbus Industrie A310s (down to four after the March crash) and four Boeing 767s.

"Yes, Transaero pushed us to do this," Brylov told me. And the pushing could intensify when the two airlines start competing on routes to the United States next year. Both have been given permission to begin regular service to Seattle, Los Angeles, and Orlando, and Aeroflot has already begun negotiations with an American partner for a joint-venture hotel near Disney World.

"There are enough passengers for everybody," said Transaero's Grachev.

At Khadarovsk, the crew of an An-24 prepares for a flight. Pilots in Russia have threatened to strike because of the general state of aviation in the country.

Guards are posted to watch over aircraft parked at Shermeteyavo-2, Moscow's international airport. Fur hats and heavy coats are necessary—even aboard an airplane, as a Russian family on a flight from Khadarovsk demonstrates.

"But if we have to compete with Aeroflot, we will. We think a lot of people will choose to fly Transaero."

Still, talk of any serious rivalry between Aeroflot and Transaero is mainly for show, since Aeroflot also happens to be one of Transaero's founding partners. Other big stockholders include the former State Property Committee, the Ilyushin and Yakovlev Design Bureaus, and the Moscow city government.

What may look like competition in

the new Russian economy is often little more than past and present state agencies combining their assets. "Something that would be a conflict of interest anywhere else falls under the heading of just another business opportunity in Russia," said Richard Dean, an attorney who headed Courdert Brothers' Moscow office during the late 1980s. In reality, without such investors and the political clout they bring with them, an airline like Transaero could never get off the ground.

The great misconception in the West about business in Russia is that capitalism has replaced Communism. What's really happened is that capitalism and Communism have merged to form a kind of state-managed semi-free market. "Bosses who learned their jobs in a controlled economy aren't about to trust their futures to anything as unpredictable as privatization," said a lawyer for a Moscow bank, who cited that fear as the main reason Aeroflot has been so slow to change.

Just as the Soviet *nomenclatura* used to work like a Communist country club, reserving the best opportunities for its members, Russian aviation sometimes seems like a giant family business. Transaero's president is 27-year-old Alexander Pleshakov, son of Tatyana Anodina, chairwoman of the powerful Interstate Aviation Committee, which certifies all new air carriers in the Commonwealth of Independent States. The company's senior vice president, Grigory Gurtovoy, is the son of Arcady Gurtovoy, who is chairman of the Yak Aircraft Corporation.

Russians often refer to such business arrangements as organized crime, clouding the distinction between legitimate business and true crime. The real Russian mafia doesn't own airlines, but it certainly understands how to make money from them.

At Moscow's Shermeteyavo-2 International Airport, the gangs are more efficient than customs agents, stealing millions of dollars' worth of cargo every year. When my flight from Washington landed, it was greeted by armed guards hired by Aeroflot to protect incoming baggage. Inside the terminal, instead of the usual signs of welcome you see on arriving in other world capitals, there were rent-a-thug push-cart operators—"the luggage mafia"—who sell their services for three dollars a suitcase.

Of course, bilking foreigners is an old game in Russia. All Russian airlines

are equally greedy when it comes to hard-currency customers, sometimes charging them over twice as much for tickets as they do Russian passengers.

A case in point is Komi Avia, another offshoot of Aeroflot. The company owns approximately 30 airplanes and flies from Moscow to various destinations in the Komi Republic, an autonomous region in north-central Russia. One of its northernmost stops is Vorkuta, a coal mining town famous for its Stalin-era prison camps. My one-way fare to Vorkuta—the idea of round trip tickets inside Russia is just catching on—came to $147. My Russian translator was charged $64. When I asked the clerk why I had to pay more, she thought for a moment, then replied, "Because you're a foreigner."

Internal Russian flights leave from Moscow's old international airport, Shermeteyavo-1. Passengers are herded like livestock through three check-in stations, then onto buses for the ride to their airplane, where a stewardess makes them wait before boarding while she checks each ticket again.

The Komi Avia Tu-134, which still had "Aeroflot" painted on the side, was packed solid with travelers headed for the frozen north. Aside from safety instructions in both Russian and Komi, everything about the flight was routine. That is, until three hours into the trip, when the pilot, after announcing we were crossing the Arctic Circle, launched into a mid-course critique of Soviet aircraft technology. "Not long ago, we used to think Soviet airplanes were the best in the world," he said. "Now we know they're not."

That's one of the reasons why earlier this year the International Airline Passengers Association warned travelers to avoid flying anywhere in the Commonwealth of Independent States. *"Only a fool with no regard for personal safety would fly Aeroflot at* any *price,"* the organization said in a strongly worded newsletter. Poor aircraft maintenance combined with political problems, the IAPA concluded, have caused "Russian aviation air safety [to deteriorate] to the level of China," which the organization ranked as the world's most dangerous place to fly. A major cause for concern among international aviation officials is that new airlines are unable to pay for safety inspections and repairs. Considering that the average Russian passenger plane has already used up 80 percent of its service life, that could have serious consequences.

On the subject of safety, a Komi Avia official in sub-zero Vorkuta assured me that all the airline's airplanes get regular inspections, as required by the Russian government. However, the watchdog Department of Civil Aviation has admitted it lacks the personnel to monitor every operator, so there's no guarantee any airline in Russia is flying safe airplanes. The situation has gotten so

Airplanes that no longer fly for Aeroflot often remain painted in the airline's colors. Eric Vercesi intends to use this Czech-built Let L410UVP-E for his charter operation.

bad that Russian pilots have threatened to strike if improvements aren't made.

Back in Moscow, Gennady Zaytsev, a retired Aeroflot pilot who is second in command at the Department of Air Transport, the agency that regulates Russia's air industry, conceded there are "some dangerous planes out there," then cited last year's one-third rejection rate for license renewals as proof that the government is cracking down. The authorities, he said, are weeding out all carriers and facilities that do not meet strict operating standards, which, for domestic airlines, include financial stability, an up-to-date insurance policy, and qualified pilots and mechanics.

Just the same, with so many airlines and airline facilities to oversee, some things inevitably go unnoticed. Critics also charge that government inspectors are often bribed to look the other way. According to figures gathered by the Russian office of the British company Airclaims Limited, there were 16 fatal crashes of all kinds of aircraft in Russia during 1993, compared with 32 the previous year. But the number of fatalities in Russian air disasters has been steadily rising. Airclaims' figures indicate that in 1993, 346 passengers and crew died in Russian air crashes. During the first five months of this year, 208 people were killed. That represents a significant increase over the reported yearly fatality rates in the entire former Soviet Union during the late 1980s: 120 in 1988, and 107 in 1989.

Over the past few years, Russian aviation has sometimes played like a page out of a black comedy. In July 1993, riot police had to be called to Moscow's Vnukovo Airport to disperse 350 angry Russian passengers who stormed the runway after waiting four days for a flight. Last May an Arkhangelsk airlines Tu-134 made an emergency land-

Former Aeroflot pilot Gennady Zaytsev (below) now sees Russian aviation descending into chaos. In Moscow, an Aeroflot Tu-154 is readied for a flight. After the March crash of an Airbus with the pilot's teenage son at the controls, Russians may wonder who will be flying the airplane.

ing in Arkhangelsk after replacing missing hydraulic fluid with lemonade. And in November Russian air traffic control in Siberia sent two British Airways and Air Nippon jumbo jets with hundreds aboard on a collision course. Disaster was averted only because the pilots were able to make evasive maneuvers.

"Sometimes I look back 15 or 20 years and think those were the good old days," Zaytsev said. "That's when we only had one airline, Aeroflot." Zaytsev, who has devoted his life to aviation, said he could only hope the future will be better than the present, which, as he sees it, couldn't get much worse. He put his hand on a thick stack of crash investigations sitting on his desk and sighed. "Each man has certain periods in his life where he goes crazy," he said, "and this is mine."

Coming TO America

Left with nothing at the end of World War II, a team of German rocket scientists was brought to Huntsville, Alabama, and given a rare chance to start over. But their stories didn't end happily ever after.

HUNTSVILLE TIMES/DAVID DIETER

by Homer H. Hickam Jr.

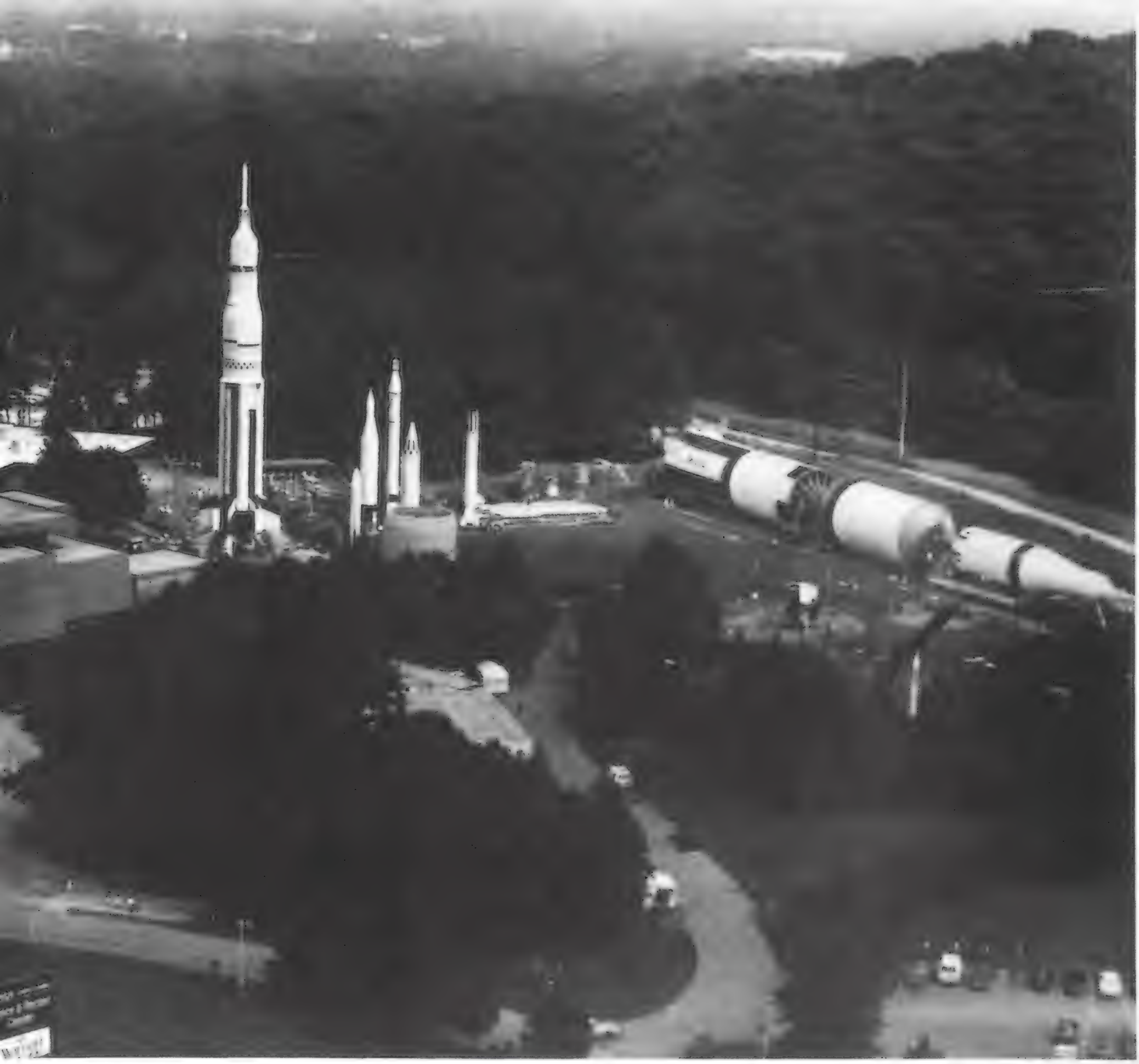
A huge rocket towers over the main building of the U.S. Space & Rocket Center museum in Huntsville, Alabama. Standing 224 feet tall, the great white rocket is easily spotted from miles away, a friendly sight for student pilots returning from the flight practice areas north of the city, as well as for astronauts in stubby-winged T-38s swinging in to land at the nearby Army-NASA Redstone Field. At the park's western perimeter another big rocket is displayed, this one 363 feet long—so huge it has been laid out on its side so that it can be properly appreciated. It was once the world's most powerful rocket. The upright rocket across the field is its older and smaller brother. No mockups, they are the real thing, machines built in service of a singular goal: carrying men, and the modules necessary to keep them alive, to the moon.

Across the valley and up into the foothills of the Cumberland plateau sits the city of Huntsville. Once it was just another little southern American town that had staked its future on cotton and soybeans and watercress. That was before a band of engineers and scientists "hit the town like a bombshell," as one of them put it later. Within two decades the group's intensive labors culminated in the two rockets that today dominate the city's space museum—the mighty Saturns. And along the way, the undertaking transformed the town into a cosmopolitan city that boasts a civic center and symphony and observatory and research institute.

Both stories, the rise in a small town's fortunes and mankind's first venture to another world, begin in the ruins of post-war Germany.

By the spring of 1945, Wernher von Braun and his team of rocket scientists were in a desperate position. At a proving ground near the village of Peenemünde on the Baltic Sea, they had designed and fielded a rocket called the V-2, a liquid-fueled weapon that could carry a one-ton warhead 180 miles and reach an altitude of 60 miles—the very edge of space. Nothing like it had ever been built, but in the months following World War II, a decimated Germany no longer had any use for it.

The conquered nation's exotic new weapons were, however, of keen interest to the U.S. military, and the Army's Technical Intelligence Team, headed by Colonel Holger Nelson Toftoy, was assigned the job of assessing them. Toftoy was particularly interested in the V-2; when the Army captured an underground V-2 factory near Nordhausen, Toftoy



The Saturn I-B (the tallest rocket standing) and V (on its side) bear witness to the industriousness of the German engineers who forever changed the landscape of Huntsville.

arranged to have the rocket parts found there shipped back to the States for further study (see "V-2: The Long Shadow," Feb./Mar. 1993).

Once the gear was on its way, Toftoy began a search for the engineers and scientists who had built the rockets. It took weeks, but finally he heard that a group of men claiming to be the inventors of the V-2 had surrendered to the U.S. Army in Bavaria. There he met von Braun, a boisterous 33-year-old scientist who acted more like a movie star than a defeated enemy. Von Braun inquired how he might be of service to Toftoy. Toftoy replied with a question of his own: Did the German scientists and their families have enough food, and did the children have milk? At that moment, Toftoy and von Braun formed a father-son relationship that would last a decade.

As part of a military operation code-named "Paperclip," Toftoy managed to have 118 scientists and their families brought to the United States so that the Germans' expertise could be tapped. One member of the group was Erich "Maxe" Neubert, who had served as an electrical engineer at Peenemünde since 1939. After the Russians had taken over Berlin, Neubert had brought his wife Margot, then pregnant, and his son Rolf to stay with relatives in the country. As Margot Neubert recalls it: "All of a sudden the war was over and the Americans were looking for my husband. They sent us a car. I was put with my things and Rolf and two more people and my husband all in the back seat and we drove that way to Witzenhausen. My husband had to report to the Americans and the driver had to give the car up. So I was just left in the middle of the street with all my clothing for my boy, and my own little clothing, and it was all in a pile on the street. Well, I tell you it was just like a bad dream. My husband left for the United States on the same day our daughter was born.

Before the war, Madison County was known mostly for its cotton (bottom) and watercress. The Germans introduced Huntsville to a host of cultural and technological wonders, such as the V-2 missile, which in the 1950s was exhibited in the town square with other missiles in a commemoration of military technology. Most of the Germans became American citizens in April 1955 (far right); by the 1960s they were producing the gigantic Saturns whose roar rang out for miles across the countryside during test-firings (right).

MADISON CO. PUBLIC LIBRARY

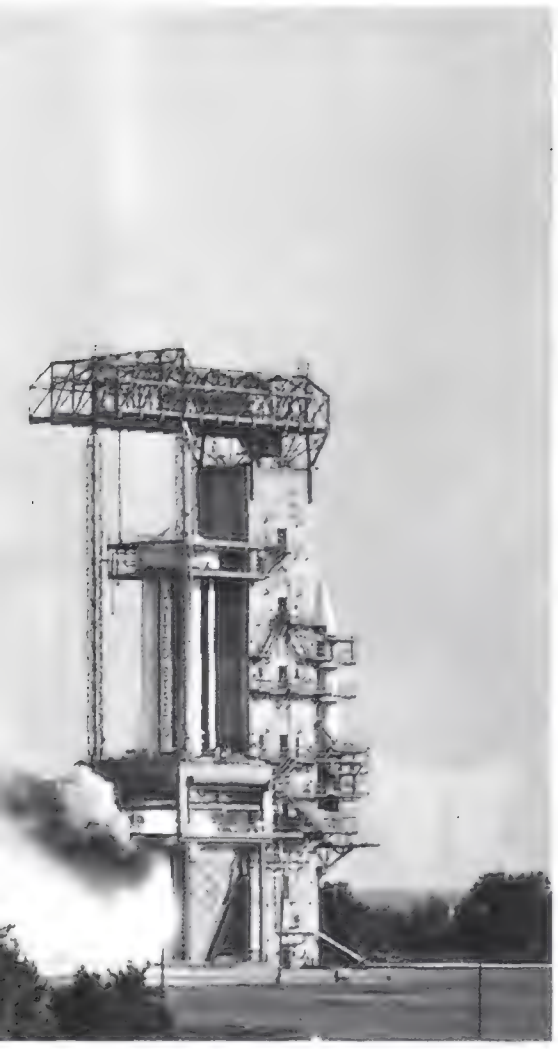
HUNTSVILLE TIMES/ALAN WARREN

He came and saw her and then was gone. I wondered if I would ever see him again."

A year later, Margot Neubert, along with other wives whose husbands had gone ahead to America, made the passage across the Atlantic aboard a Liberty ship. They landed in New York, then boarded trains for Texas. The von Braun team had been quartered at Fort Bliss, but their first assignment was at the new White Sands Missile Range, just across the state line in New Mexico. There, working with Army technicians and contractors, they began to assemble the V-2s and test them.

Just when the Germans had started to get comfortable in Texas, they were caught up in a classic case of American pork barrel politics. John J. Sparkman, a powerful U.S. senator from Alabama and a native of Huntsville, was determined to find some way for the defense department to make use of the defunct Huntsville and Redstone Arsenals just outside Huntsville's city limits. Toftoy, now back in the States and charged with watching over the German scientists, heard of Sparkman's interest and quickly saw the possibilities. He flew to Washington and got the Pentagon to agree to convert the chemical and ordnance plants into a new Army Ordnance Guided Missile Center. In 1950 the von Braun team was told to get ready to move to Alabama.

At the time, Huntsville's population stood at 16,000. The town, barely four square miles in size, was centered on an outflow of water known as Big Spring, around which stood a courthouse and several small businesses. The largest employer was a cotton mill. Philip Bentley, owner of a Huntsville car dealership since 1946, recalls: "Oh, it was a wonderful town then. The farming people and the people in the mills were just good, everyday people. Everybody knew every-



NASA/MARSHALL

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body else. There wasn't any crime, life was kind of slow and easy. I loved every minute of it."

Another Huntsville native, however, remembers the town differently. "There wasn't anything outside of the center of town except those old mills surrounded by a bunch of sorry old mill houses," she says. "North of town was a line of honky-tonks filled with a bunch of roughnecks. Except for the old ammo plant that had been abandoned, that's all there was in this place. I don't think the businessmen around the square were all that enthusiastic about anything changing either."

The lack of enthusiasm was somewhat understandable. During World War II, when the two arsenals had employed 20,000 workers, a boomtown mentality had swept the town. Residents had given up farming and taken government jobs, and the old Huntsville families had invested in hastily built apartment buildings and subdivisions. After the war ended, the arsenals closed and the apartment buildings and subdivisions fell into decay. A great deal of money was lost. By 1950, the old Huntsville families who controlled the banks and the businesses wanted nothing more to do with boom and bust.

In April, von Braun and some of his compatriots journeyed to Huntsville to check out the town and its facilities. Engineer Konrad Dannenberg, who was on that trip, recalls: "Immediately, we liked it very much because [compared to Texas] the land was much more like Germany. But it was also very small and some of us had a concern if we would be welcome." In the post-war years, Americans had expressed anger at having to accommodate recent enemies. The Federation of American Scientists termed it an "affront to the people of all countries who so recently fought beside us." Citizens wrote letters to Congress decrying the Germans for reaping the benefits of a war they had started.

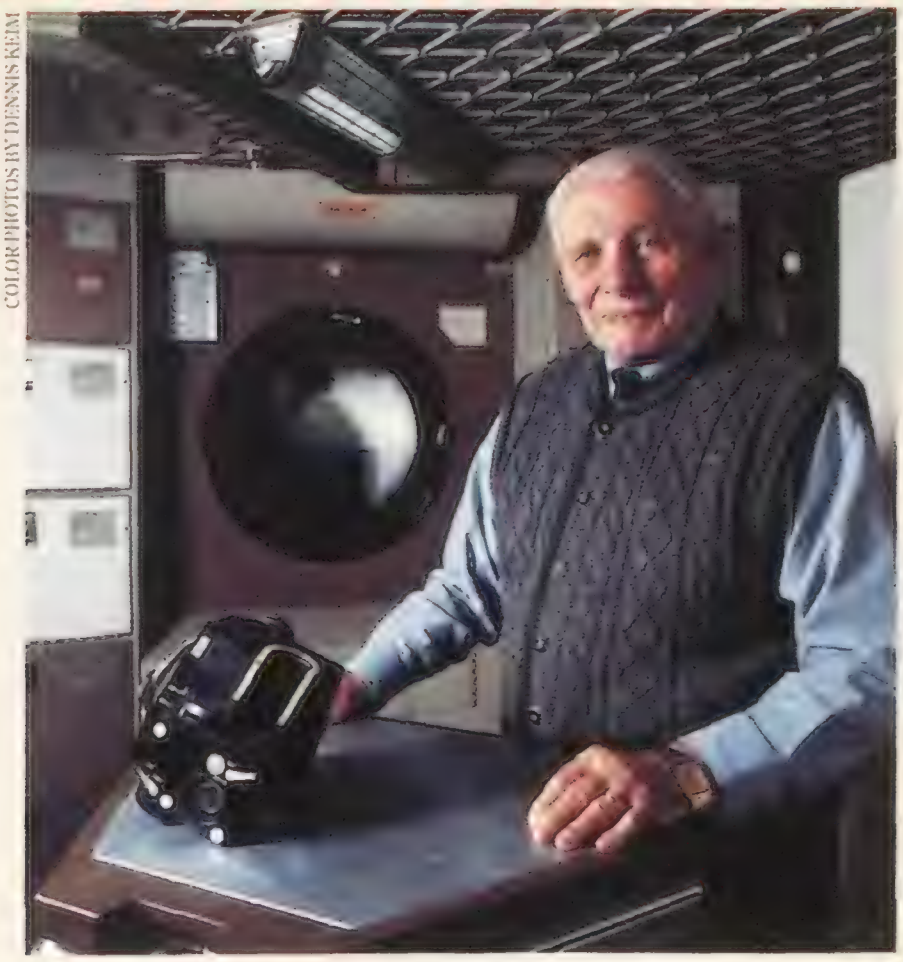
Perhaps believing that they would feel more secure in Huntsville if they stuck together, one group of Germans talked of forming an enclave of sorts where they could live near one another. Two of the Germans accompanying von Braun on that initial trip investigated a 37-acre farm atop Monte Sano, a heavily forested mountain overlooking the town. After some quick negotiations, Leopold Osthoff, acting on behalf of the group, bought the property for $7,200. One of the wives made a clay model of the site and brought it back to Texas. From the model, the other families picked out their lots.

Two months later the rest of the team and their families started to arrive. If some of the locals were unsure of the new arrivals, some of the Germans were likewise not entirely happy with what they found. "It was just a little cotton town, you know," engineer Gerhard Reisig recalls. "There was practically no cultural life at all. My interest was in music, for instance. We formed right away a chamber music group. And what we found was that some of the people appreciated what we were doing and some did not. I remember there was a Huntsville gentleman, a banker I believe, who told me very frankly this: 'We like your money but we like our way of life and do not care to see it changed.' "

Margot Neubert had mixed feelings about the move. She thought the land itself was beautiful. "My husband drove me across the mountain and I looked down on this wonderful valley and I felt so happy. 'Oh, Maxe,' I said to him. 'I love it.' " Her future home was another story. "I will never forget the first time I saw the property," she sighs. "My husband got this machete and I said, 'What are you up to?' And he said, 'Well, we cannot see too much. It's sort of grown over.' So here we go up on the mountain and then the road got smaller and smaller and he parked somewhere in a ditch among weeds. Then he took out that machete from the trunk of the car. I was wearing a nice dress and hose and shoes but he said, 'Don't worry, I'm going to cut you a trail.' I tell you I couldn't believe it! All I could see were everywhere sticks, sticks, sticks! I said, 'Come on, Maxe, be a good sport.

Paperclips, Then and Now

COLOR PHOTOS BY DENNIS KEIM



BLACK AND WHITE PHOTOS COURTESY MARGOT NEUBERT

Bottom row (left to right): Wives and children at Fort Bliss (Margot Neubert is in the dark top); the Neuberts in New Mexico; Bert and Joe Fikes, who came to Huntsville with the Germans; Walt Wiesman, who gave lectures on industrial communications after retiring from NASA.

Top row (left to right): Propulsion engineer Konrad Dannenberg, who became a consultant and part-time professor after leaving NASA; Margot Neubert, widow of electrical engineer Maxe Neubert; the Paperclips at White Sands, New Mexico (Maxe Neubert is in the chair at center).

NASA/MARSHALL (2)

After bringing the Germans over after the war, Holger Toftoy (second from left) worked with them until 1958, when he was transferred out of Huntsville. Here he confers with (from left) J.J. Fagan, Hermann Oberth, and Ernst Stuhlinger.

You cannot mean this!' He said, 'Yah, we build here.' I said to him, 'I am from Berlin. I cannot exist in such a place.' The next day again I tried to talk him out of it. But he said, 'I told you yesterday, we are building on the mountain or not at all.' "

Other Germans decided to find housing elsewhere. Von Braun, for one, felt that a German enclave would be too clannish. Katherine Edwards, a Huntsville native, remembers that the rocket scientist first moved into a small frame house across from her relatives. "My Aunt Jesse was afraid he was going to blow them up or something," she recalls with amusement. "But one day Mrs. von Braun, who was real quiet and shy, knocked on Aunt Jesse and Uncle Albert's door, holding her baby. She wanted to know if she could sit in the swing on their front porch, to rock the baby. Aunt Jesse said, 'Honey, you can use that swing any time you want to.' And Mrs. von Braun did too. Sometimes real late at night, after everybody had gone to bed, Aunt Jesse would hear Mrs. von Braun on her porch, swinging the baby."

Some Germans quickly worked their way into the life of the town. Walt Wiesman, one of the younger team members who had served as a sergeant in the Luftwaffe, became president of the Huntsville Junior Chamber of Commerce even before he became a citizen. "Listen," he says now, "there was no mystery to my acceptance. It was just a matter of a young man entering the circle of other young men. If anybody ever got cute talking about the war, I just told them I was 12 years old when Hitler took over and I was drafted when I was 19. 'What would you have done?' I asked them. That shut them up pretty quick."

Although the German-born scientists and engineers made up the core of the von Braun team, most of the workers flooding into Huntsville were Americans, and they also had to fit into the town. When Joe and Bertha ("Bert") Fikes moved to Huntsville, they found the reception not entirely pleasant. "One woman was real snooty and told me her family was fifth generation in Madison County," Bert Fikes recalls. "I said, 'Honey, we're all fifth generation from somewhere!' I just developed a sense of humor about it after a while. We were here to stay whether they liked it or not."

As their families began to settle in, the team members went about setting up a new Redstone Arsenal, incorporating the two old arsenal properties. With their own labor, they converted an Army hospital into a Guidance and Control Laboratory. Unhappy about the $75,000 bid a contractor had made to build a static-test stand for rocket motors, they used abandoned hardware and built it themselves for $1,000. More ambitious projects soon followed. In the early 1950s Army intelligence indicated that the Soviets were making rapid progress in the field of rocketry and might soon be capable of fielding a nuclear-tipped missile. The team at Redstone Arsenal was given the job of developing a ballistic missile that could carry a nuclear weapon 200 miles. Holger Toftoy, now a general, named the rocket in honor of the arsenal: the

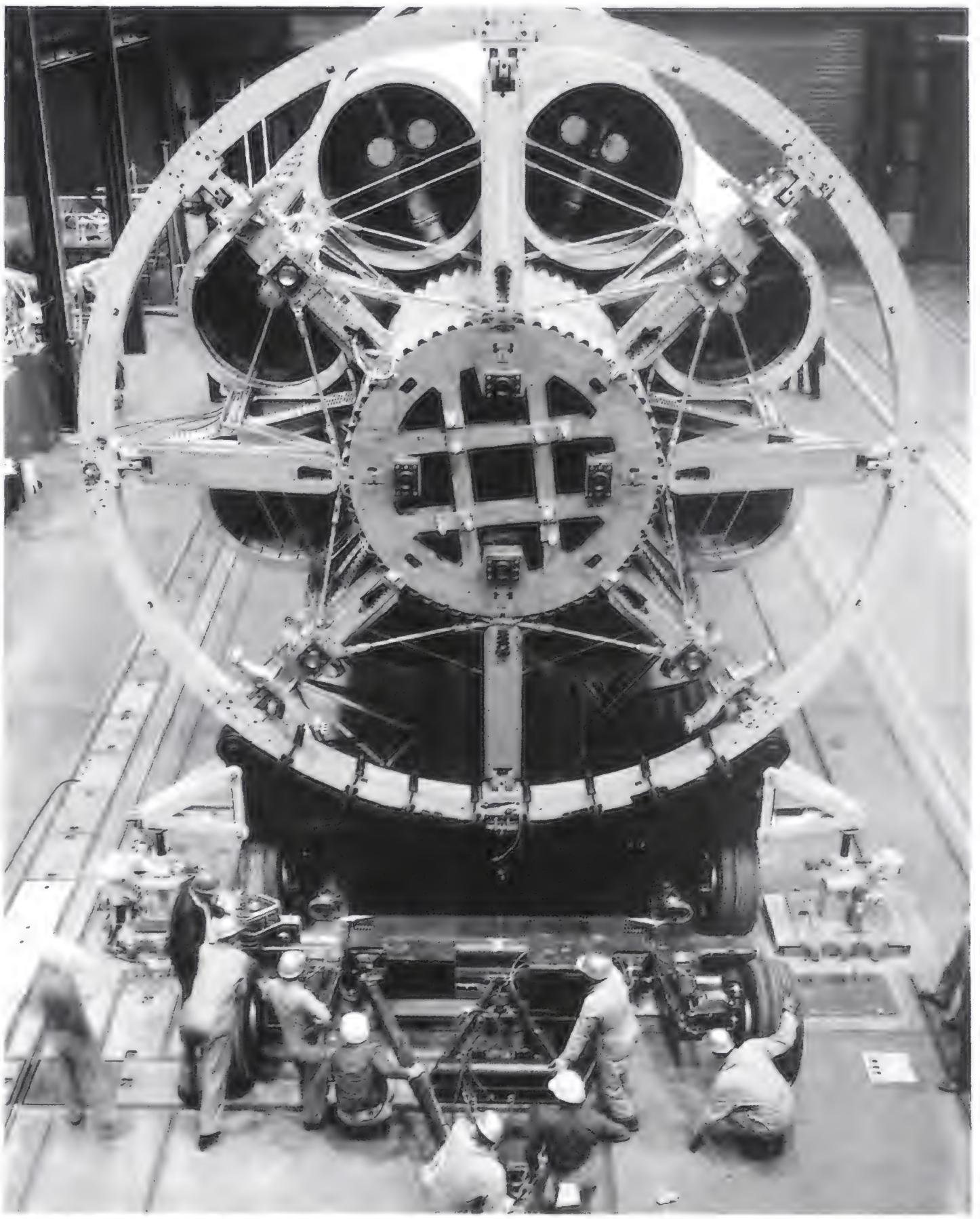
Redstone. Rather than farm out the work to a contractor, the team built and tested the first Redstones entirely in house.

The mix of employees at the Redstone Arsenal was potentially volatile. Most of the locals were World War II veterans, and many of the Germans served as their supervisors. But townspeople who recall those days at the plant have few memories of significant friction between the two groups. One native, Bill Stennett, worked with a team of pipe-fitters and machinists under a German boss. "Oh, some of the guys would kid around a little," he recalls. "One man had been a paratrooper and had jumped into the Black Forest of Germany. I remember him telling one German that he'd have been dead if he had caught him back then. I don't remember any of the Germans ever saying much back when the talk went that way. I'll tell you one reason why there wasn't much of that kind of thing and it was because we were all so busy all the time. We were working six, seven days a week, 12, 14 hours a day. You work like that and you don't have time to think about much else."

As the work at the Arsenal grew, so did the city of Huntsville, often assisted by the new immigrants. The chief architect of the Peenemünde proving ground, Hannes Luehrsen, laid out a new highway system for the expanding city. An observatory was founded on Monte Sano, its first telescope made by the team members. Von Braun himself would go to the Alabama legislature in 1961 and return with funding to start a scientific research institute as part of the rapidly growing University of Alabama in Huntsville.

On January 31, 1958, the von Braun team, under the leadership of General John B. Medaris, put the United States' first satellite, Explorer 1, into orbit aboard a four-stage Redstone-based rocket called the Juno 1. Soon after, President Eisenhower ordered the team to re-form under the new civilian National Aeronautics and Space Administration. Von Braun was named the first director of NASA's George C. Marshall Space Flight Center in Huntsville. When, in 1961, President Kennedy assigned NASA the goal of putting a man on the moon within the decade, the von Braun team was given the task of building the rocket that would take him there. Two of the launchers that emerged from that effort—the Saturn I-B, used in the earth-orbiting missions, and the larger Saturn V, used in the lunar landings—are the big rockets on

To take advantage of existing technology, the von Braun team created the first Saturn rockets out of clusters of tanks made for earlier vehicles.



display today at the U.S. Space & Rocket Center in Huntsville.

During the 1960s, the city became accustomed to the rolling thunder from the giant Saturn engines being tested on a big new test stand; for miles around, the rumbling loosened plaster, cracked windows, and stopped hens from laying. In Huntsville, the sound was a triumphant one. But the triumph took its toll.

For the families enduring the men's prolonged absences, the strain was wearing. Claus Kroeger recalls that his father, Hermann "Ewan" Kroeger, "was gone all the time. He would be gone in the morning before we got up and back after we were in bed. There were times when they would do the launch countdown tests where he would be gone four and five days—he would just stay out there."

Reflecting on his father's intense dedication, Kroeger observes: "After the war there was absolutely nothing left for him to do. The whole country was in ruin. He had two little children. Here represented an opportunity to go and work and do something, to utilize the skills that he had for something more noble than bombs. I don't think he had any delusions about that—he did work on military things, after all—but in the end there was a fair amount of pride for all of them that they were working on something so ingenious and doing it for this country. I feel like they were just so damn glad to be in America that they put all their heart and soul into it. Sometimes that meant their families had to take what was left over."

The team's children turned to each other for support, though some were also able to find companionship with kids from different backgrounds. Bert and Joe Fikes lived next to a German family, and Bert recalls: "I would look out the window sometimes and there would be our sons and their sons playing and they would all be just little American boys."

But other children from German families had a harder time being accepted. One Huntsville native remembers: "We didn't care for them at all. They looked funny, wore strange haircuts, studied all the time.... I understand now, how their parents wanted them to keep the old customs and to excel in school. But at the time I just thought they were being unfriendly."

"My children always wanted to be just one of the crowd," Margot Neubert remembers. "They didn't want to be thought of as anyone different. But of course they stood out. They were very tall and fair. My daughter came to me and said once that she was called a Hun at school. She didn't like that but she did not blame the children who said it. I think in a little way it was my husband and me she blamed. When I was with my children and their friends, I always spoke English and if I made a mistake they corrected me. And if sometimes I got carried away with my stories on the war and when we first came here, my daughter would say *Please*. And then I would stop."

MADISON CO. PUBLIC LIBRARY (2)

When Wernher von Braun was transferred to Washington in 1970, the people of Huntsville staged a parade in honor of their most famous fellow citizen (above, left to right: von Braun successor Eberhard Rees, von Braun, wife Maria, son Peter, and daughter Margrit).

The von Braun team, in the end, delivered all that it had promised. Ten Saturn I's, nine Saturn I-B's, and 13 Saturn V's would be launched, all successfully. Team member J.R. Thompson, who later became director of Marshall, attributes the success to a thorough test program. "They even tested to failure, pushed their engines as far as they would go," he says of the team. "Analysis is all well and good, but you have to get outside and test to really see how something works."

Joe Fikes recalls another factor in the team's success: "What Marshall did was look over the shoulder of the guys at their plant. A lot of us knew what was going on on the production line better than the company's own managers."

Of course, the ultimate reason for the success of the Saturn program was the gregarious and galvanizing man at the top. Margot Neubert remembers a meeting where leading space scientists were addressing the public: "Everybody was

half-asleep. And then Wernher came through the door and it was as if electricity had come in with him. When he started talking—I can still get goose bumps even now—everybody in that room followed every word he said."

Most of the von Braun team and their families would make the journey to Cape Kennedy at least once to see what their work and sacrifice had wrought. Margot Neubert remembers her trip: "I was the wife of a VIP so I got a very good view. When the Saturn went off, it was unreal. It was so huge it stopped your heart. I tell you I saw grown-up men with tears streaming down their faces."

The Huntsville engineers were determined to make the Saturns into a family of rockets that could fulfill the country's long-term space plans, including building installations on the moon and journeying to Mars. But by the mid-1970s it was all over for the Saturn program and the von Braun team. The first indication was von Braun's transfer from

Huntsville to NASA headquarters in Washington, D.C., where he was effectively isolated from the Marshall center. Von Braun retired from the agency in 1972 and died five years later.

Eberhard Rees, von Braun's deputy during the Saturn years, took over as the center's director but was soon replaced by Rocco Petrone, Apollo program director at NASA headquarters. Once installed, Petrone was charged with cutting over 1,000 civil service employees and 2,000 in-house contractors from the center's payrolls. By the time he left Marshall less than a year later, most of the German team members were gone.

The reasons for the shakeup are still being debated. According to a story by Peter Cobun in the *Huntsville Times*, some NASA officials had long resented the Germans for "filling key managerial and laboratory slots with their own; demanding full and unrestricted control of the operation; circumventing the system and its established policies; [and] attempting to research, develop and build a rocket system in-house," rather than open up their projects to outside experts. Some on the von Braun team felt the job cuts were in part intended to redress these grievances; in the words of Ernst Stuhlinger, von Braun's chief science advisor, "[Petrone] came here with orders to reduce Marshall Space Flight Center in size and 'Americanize' the organization."

However, Frederick I. Ordway III, a Marshall branch chief at the time, points out that in the years following the Apollo 11 moon landing, funding was cut for all the NASA centers. The breakup of the German team, others argue, was largely a matter of circumstances: many of the members were already at the age of retirement, and moreover, civil service rules on job cuts stipulated that U.S. veterans be accorded more protection than others.

Some of the Germans had trouble adjusting to life after NASA. After being demoted to a position of little authority, Ewan Kroeger retired in 1974. "[My father] did virtually nothing after retirement," Claus Kroeger remembers. "His work had been everything. My mother died in 1970 after being an invalid from a stroke, and we boys had all moved away, so he was alone." Kroeger died in 1986.

Another German, Arthur Rudolph, who had directed the Saturn V program, also fared badly during his retirement. In the early 1980s the Department of Justice's newly formed Office of Special Investigations began looking into Rudolph's service as production director of the German V-2 facility known as Mittelwerk. The OSI alleged that Rudolph had used prisoners for slave labor and had done nothing to alleviate their brutal mistreatment. To avoid a war crimes trial, he signed a statement agreeing to give up his U.S. citizenship and move back to Germany. Rudolph has since filed a lawsuit to have the agreement rescinded, arguing that the OSI had lied to him about the evidence it had collected.

The Germans in Huntsville were shaken and outraged by the Rudolph affair; some of the Americans who were part of the von Braun team were also deeply upset. "The Germans came to this country under the auspices of the United States government," says the wife of an American engineer. "The government knew their background completely. Nothing new had been found out about Dr. Rudolph but they came after him anyway. This they did after the man had spent his lifetime doing good for the United States and being a good citizen."

Other Germans made the best of their retirement years. Konrad Dannenberg became a space consultant and part-time professor; Eberhard Rees also became a consultant. And Ernst Stuhlinger, working with Frederick Ordway, recently came out with a two-volume biography entitled *Wernher von Braun: Crusader for Space.*

Like Ewan Kroeger, Maxe Neubert felt the reorganization left him no choice but retirement. Margot Neubert watched him struggle. "All those first years after his retirement, every morning when he was having his coffee he started again

arguing about the space program and what a loss it was. Finally I said, 'Maxe, why don't you stop it? It's over. You have experienced it in all its glory and you have experienced it going downward. Now forget about it.' And you know I even gave him a tape recorder so when he was up at night and he started going through all these years—because these were areas he just could not stop thinking about—he could talk it out.

"I thought [retirement] would kill my husband in one or two years," she continues. "But after a while he was okay and it was the best years we had. I said to him, 'Why don't you have a consultant's job?' Because I knew those companies were trying to catch him. But he said, 'No, I have retired and I don't want to see or hear anything more about it.' He had had enough."

Maxe Neubert later developed cancer of the stomach, but he continued to enjoy his retirement years. "We would often work in our yard...and he would stop and just look with so much joy out over the city and the countryside," Margot Neubert recalls. "We saw no lights when we first built. Then the city grew and we started to see the lights blink on, one by one. You can see the rocket [test] stands from the mountain, you know."

Maxe Neubert eventually had to go into the hospital. His last days before his death in 1990 were spent drifting in and out of consciousness. "I went once to see him and he was trying to talk," his wife says. "I could not tell if he was using English or German. Then I heard him say, very clearly, 'von Braun.' When I bent close to hear, he was talking about space and I knew he was with Wernher and all his fellows."

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The Brave New World of Deregulation

PAN AM

Smiling was easier for airlines and their employees in the pre-deregulation era.

Rapid Descent: Deregulation and the Shakeout in the Airlines *by Barbara Sturken Peterson and James Glab. Simon & Schuster, 1994. 352 pp., b&w photos, $25.00 (hardcover).*

The airline industry has been compared to the Bourbon kings—"nothing learned, nothing forgotten," in Talleyrand's phrase. The industry's cycle of misery is indeed unyielding because it is self-renewing. In good times, the carriers buy too many airplanes, often larger ones. The new equipment permits, or dictates, expanded service, which in turn promotes more battling on more routes between a diminishing number of airlines. In bad times, of course, the combination of excess capacity and a shrinking market takes a heavy toll. Still, however weak their balance sheets may become, most carriers will continue pressing for the largest possible share of the market. Market share is an end in itself even if the struggle pushes the larger goal—financial stability—farther out of reach.

The airlines and their troubles provide a good story—episodic, rich in anecdote, and stuffed with robust personalities. *Rapid Descent* lives up to its title by vividly tracing the downward spiral of the carriers as they left their clubby, controlled environment for the bracing new world of deregulation. All or most of the major pieces of the story are here, along with the cast of characters. In 1974, Stephen Breyer, the current Supreme Court justice-designate who was then working on Senator Edward Kennedy's staff, had determined that the regulated airline industry constituted a government-run cartel. Breyer's role in fostering a new and freer structure is described, along with that of Alfred Kahn, a picturesque figure (he describes airplanes as "just marginal costs with wings") and the putative architect of airline deregulation. He wasn't alone, however. According to another industry insider, "If you poked an economist then, and said 'airlines,' they'd say 'deregulate.' "

Moving on, we find American's Bob Crandall contesting successive CEOs at United for the industry's lead position. Among the key players, Crandall seems to have been the most resourceful; he launched the "Super-Saver" coach fares, and he saw the potential of frequent-flier programs before any competitor. American's data processing lagged for a time, we learn, but Crandall eventually leapfrogged the competition by creating Sabre, the industry's preeminent computer reservation system.

Smaller and weaker carriers, along with failed wannabes, receive equal attention. We see People Express becoming the "fastest growing company in America" and then going utterly broke over a period of just nine months. The new entrants were warned: "The big guys will lose money as long as it takes to get rid of you," an experienced airline analyst told a representative from one of the upstarts.

Although informed opinion—including, it seems, the authors'—is split on how or what to think about deregulation, the experience hasn't borne out any of the reformers' bright forecasts. Speaking in defense of the newly deregulated airlines in 1977, Alfred Kahn said, "I believe that business men do not want to commit suicide and rush into markets." Just last year, however, we find Steve Wolf, United's boss, telling his shareholders that in the current environment their company and the other mega-carriers were "in danger of becoming corporate dinosaurs."

—John Newhouse is a staff writer for the New Yorker.

ENCORE!

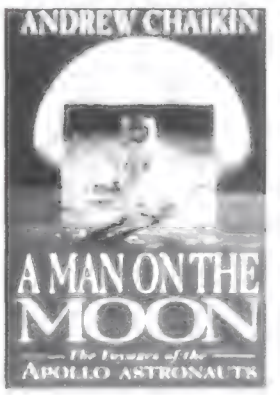
Flight in America: From the Wrights to the Astronauts, Revised Edition *by Roger E. Bilstein. Johns Hopkins University Press, 1994. 386 pp., b&w photos. $50.00 (hardcover), $16.95 (paperback).*

Widely praised when it was first published in 1984, this comprehensive history of flight in America has been revised and expanded.

A Man on the Moon: The Voyages of the Apollo Astronauts *by Andrew Chaikin. Viking, 1994. 670 pp., $27.95 (hardcover).*

Andrew Chaikin's *A Man on the Moon* (portions of which have appeared in this magazine) is a book that was waiting to be written. Though there are many books about the Apollo missions, this is the first to combine the later recollections of all the Apollo astronauts with other sources, including the recollections of lunar geologists and engineers. Some of the sources—such as tapes of the astronauts' onboard conversations—have been available only in recent years. Armed with this material, old and new, Chaikin successfully weaves together the stories of all these people, though the astronauts' recollections are in the foreground. The result is a rich fabric connecting the Apollo missions into a single intricate tapestry.

There are many side stories that Chaikin chases through his narrative—the convoluted crew selection and crew changes, the continuous backdrop of wives and families (a sort of Greek chorus affected by but not affecting the main events), and the steady loss of public and Congressional interest after the Apollo 11 lunar landing. In the case of Apollo, the whole is clearly greater than the sum of its parts, and Chaikin keeps his eye steadily on the cumulative effect of the missions, which might otherwise run the risk of seeming repetitive.



A Man on the Moon picks up more or less where Tom Wolfe's *The Right Stuff* left off—but it does so much more gently. It is a thoughtful, sensitive book, full of little epiphanies: William Anders' realization, on Apollo 8, that a hole in the stars was the moon itself; Jim Lovell's discovery on Apollo 13 that one way to keep warm in the frigid, powered-down spacecraft was to keep very still so that his own warmth built up around him like a blanket; Harrison Schmitt's observation that moondust, oxidizing in the lunar module's cabin, smelled like gunpowder.

Chaikin's own obvious enthusiasm for the subject helps carry the book along. Whereas *The Right Stuff*—and also Alan Shepard and Deke Slayton's *Moon Shot* (which I reviewed in the June/July issue)—tend to wow the reader by hitting him or her over the head, Chaikin's book manages to get inside the heads of the participants and hence inside yours. If you want a continuous pounding ride through max Q, read those other books. But if you want to ride a smooth trajectory to the moon, with all its complexities and subtleties, read this one.

—Henry S.F. Cooper Jr. wrote about the Apollo landings for the New Yorker.

To Fill the Skies With Pilots: The Civilian Pilot Training Program, 1939–46 *by Dominick A. Pisano. University of Illinois, 1993. 197 pp., b&w photos, $34.95 (hardcover).*

The Civilian Pilot Training Program was one of the New Deal's more imaginative responses to the lingering economic crisis of the 1930s. It was also one of the linchpins of Franklin Roosevelt's aviation policy. Yet until the appearance of this slim volume by Dominick A. Pisano, a

INTERVIEW

The Third Planet: Exploring the Earth From Space by Sally Ride and Tam O'Shaughnessy *(Crown Publishers, 1994, 46 pp., $15.00, hardcover)* is the former astronaut's third children's book. She talked about it during a recent visit to the National Air and Space Museum.

What inspired The Third Planet?

My traveling talk for the last couple of years has been on observing the Earth from space and using pictures taken by astronauts in the space shuttle to try and describe, in a nice visual way that people can relate to, what instruments can see if they're put in Earth orbit. The photographs taken by astronauts turn out to be a pretty effective way of doing that. And so, after honing that talk—and particularly giving the talk to a lot of kids—I just developed the idea for a children's book because I think that it's an ideal way to get across to younger students—middle school students—the value of space-based observations of the Earth, and teach them a little bit about the planet.

How did you first get involved writing children's books?

I'm actually not sure.... After my shuttle flights I was spending a lot of time speaking to students, and speaking to lots of groups, but the ones that I particularly enjoyed speaking to were the young girls, particularly, and students. I had lots of offers after my flights, and I decided not to take advantage of most of them. But the thing that did interest me was trying to speak to children in some way and just give them an idea of some of the things I've been through and some of the things I've seen. So I don't remember when, whose idea it was, or exactly how long ago, but it's something that's been with me for a while.

As a child, were you influenced by books about space?

I actually don't remember many books about space. I remember the adventure books that were based on science. I remember reading the Danny Dunn series. So I grew up on that sort of book, but not really on books about space. But I was just fascinated by the early Mercury and Gemini flights. Those were going on when I was growing up and watching early television of splashdowns and astronauts being fished out of the ocean.

Do you have plans for writing more books?

Not right now. I'm going to rest a little bit. These things really take a lot of time and energy. I'm probably going to see how this one does and see whether I get another idea for one. I don't have one planned right now.

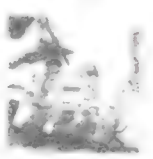
I've been asked several times to write, you know, my "life story" or "the inside story of NASA," and I just don't have any interest in writing a book like that. So that's nowhere on the horizon.

What else are you working on, in addition to children's books?

I'm a professor of physics at University of California, San Diego. So that takes up most of my time. I've got graduate students, I teach undergraduate classes, and I'm involved in physics research.

One last question: What objectives do you believe the U.S. space program should be pursuing?

I think Mission to Planet Earth is one of the most important objectives that the program has enunciated recently. It's something that's of increasing importance. It seems as though the more we learn, the more we realize we don't know, and the more important it becomes to carry out the program.



curator at the National Air and Space Museum, it was hard to find in the vast literature on the New Deal even a passing reference to the program.

Launched in 1939, the program was the brainchild of Robert H. Hinckley, a one-time fixed-base operator turned New Deal bureaucrat. It was Hinckley's goal, Pisano tells us, to "permanently air condition young Americans to 'a three-dimensional world' " by teaching them to fly. Doing this, Hinckley reasoned, would give the moribund general aviation industry a badly needed boost. It would also produce a valuable pool of civilian pilots that would be available for military service during time of war.

"Air conditioning" took the form of a government-sponsored vocational education program at institutions of higher learning. Over the five years of the program's existence, the federal government spent nearly $275 million to introduce American college students—men and women, black and white—to aviation. The program's cancellation in mid-1944 was due in large measure to its success. More than 435,000 men and women earned their wings in the program's combined pre-war and wartime phases. Add the thousands trained by the Army and Navy, and it's clear that America's youth had indeed been "air conditioned."

With today's policymakers proposing vocational education to counter job dislocations created by a changing economy, Pisano's account of this long-neglected topic is particularly timely. It is also balanced, solidly researched, and workmanlike.

—Aviation historian Nick A. Komons is working on a history of the air traffic controllers' strike.

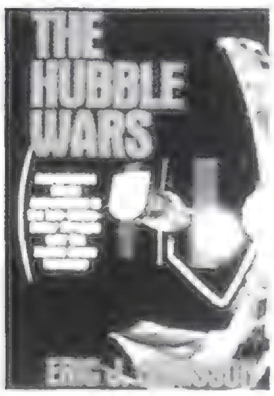
TELEVISION

"Flight Over Africa," produced by National Geographic Explorer and scheduled for broadcast on cable station TBS as a two-part series on September 11 and 18, follows a 31-year-old Pennsylvania pilot named Thomas Claytor as he flies across Africa during a six-year round-the-world flight.

The Hubble Wars: Astrophysics Meets Astropolitics in the Two-Billion-Dollar Struggle over the Hubble Space Telescope *by Eric J. Chaisson. HarperCollins, 1994. 386 pp., b&w and color photos, $27.50 (hardcover).*

This remarkable report of the trials and tribulations that followed the launch of the Hubble Space Telescope has the same characteristics as a suspenseful "whodunit." From the start you know crimes will be committed and what they will be. You also fear that the perpetrators will go unpunished because human failings are impossible to prosecute. Yet you read on, increasingly fascinated by the inertia of the NASA bureaucracy in charge of the mission and ever more horrified by the actions of its public relations arm.

The Hubble Space Telescope was an awesome technological achievement that turned into a nightmare as the scientists confronted its shortcomings: a lower-than-desired orbit, imperfect vision, and a tendency to vibrate every time it crossed into or out of sunlight, to name but a few. Add extraordinary examples of human incompetence and you are left wondering how anything was ever salvaged of the mission.



Chaisson carefully portrays the behind-the-scenes chaos as disaster upon disaster was confronted. There was much more to this story than reached the public at the time. It was a tale of individuals overwhelmed by the enormity of their multibillion-dollar responsibilities, much of it faithfully recorded in the copious notes Chaisson made while serving as public information officer and senior scientist at the Space Telescope Science Institute in Baltimore.

By the end of the saga one aches to know the names of those astronomers who argued selfishly over "proprietary" images and refused to allow their release, even if the fate of the project depended on it. Fortunately, their actions were offset by the extraordinary efforts of many astronomers and programmers whose creativity enabled the restoration of the Hubble's flawed optics and thus the rescue of the telescope from fiscal oblivion. This was accomplished as the bureaucrats battled the astronomers while at the same time trying to create the illusion that all was well, even as the mission was sinking ever deeper into a morass of technical problems.

—Gerrit L. Verschuur is a contributing editor for Air & Space/Smithsonian.

CREDITS

Up in Smoke. James V. Shannon was launch planner for fire control and guidance on the Polaris program at Cape Canaveral.

Streaking Through Cyberspace. Daniel Ford is a frequent contributor to *Air & Space/Smithsonian*, most recently on Martin Marauders at Utah Beach (June/July 1994).

Beyond the Iron Curtain. William E. Burrows is a contributing editor for *Air & Space/Smithsonian*, the author of *Deep Black*, and the co-author of *Critical Mass: The Dangerous Race for Superweapons in a Fragmenting World.*

Thirty Seconds Over Hollywood. Freelance writer and pilot Joseph Bourque is based in Bozeman, Montana. He wrote "Fantasy Islands" for the Apr./May 1993 issue.

My Quest for Queen Bess. Doris L. Rich is the author of *Amelia Earhart: A Biography* (Smithsonian Institution Press, 1989). She is now working on a third aviation biography, a story of the Moisant siblings: Alfred, John, and Matilde.

Practicing Safe Software. While it is customary to accept responsibility for published errors, Billy Goodman prefers to lay the blame on his software.

Further reading: *Digital Woes: Why We Should Not Depend on Software*, Lauren Ruth Wiener, Addison-Wesley, 1993.

The Unfriendly Skies. Bill Thomas, a former reporter for the *Baltimore Sun*, is the author of *Red Tape: Adventure Capitalism in the New Russia* (Dutton, 1992). His latest book, *Club Fed: Power, Money, Sex & Violence on Capitol Hill*, will be published by Scribner's this fall.

Coming to America. Freelance writer Homer H. Hickam Jr. considers himself an adopted son of Huntsville, having lived there on and off since 1969.

Northwestern Exposure. Writer Jim Anderson is based in Sisters, Oregon.

CALENDAR

August 11–14
Sentimental Journey Fly-In. William T. Piper Memorial Airport, Lock Haven, PA, (717) 893-4200.

August 19
National Aviation Day. Wright Brothers National Memorial, Kill Devil Hills, NC.

August 20 & 21
Aerodrome 94. Lake Guntersville Aero, Inc., Guntersville, AL, (205) 582-4309.

Prairie Airshow '94. Sponsored by Prairie Aviation Museum. Bloomington, IL Airport, (309) 663-7632.

August 21
Vintage Aircraft Display. Antique/Classic Chapter 11 of the Experimental Aircraft Association. Capitol Airport, Brookfield, WI, (414) 962-2428.

August 25–27
Aviation Aerospace Expo. Salt Lake Municipal Airport, Salt Lake City, Utah, (801) 359-3976.

August 27
Albuquerque Intergalactic Reception. UFO landing strip and science fiction movies. Albuquerque Convention Center Parking Structure, Albuquerque, NM, (800) 284-2282.

August 27 & 28
EAA Chapter 36 Fly-In. Washington County Airport, Hagerstown, MD, (301) 739-0074.

Tillsonburg Air Show '94. Tillsonburg Municipal Airport, Ontario, Canada, (519) 842-9805.

September 10 & 11
50th Annual Static Display and Airshow. Frontiers of Flight Museum, Love Field, Dallas, TX, (214) 350-3600.

29th Mid-Eastern Regional Fly-In. Marion, OH, (513) 849-9455.

Northeast Flight '94 Airshow. Schenectady County Airport, Schenectady, NY, (518) 377-2191.

September 17 & 18
Eighth Annual North Central EAA "Old Fashioned" Fly-In. Rock Falls, IL, (708) 513-0641.

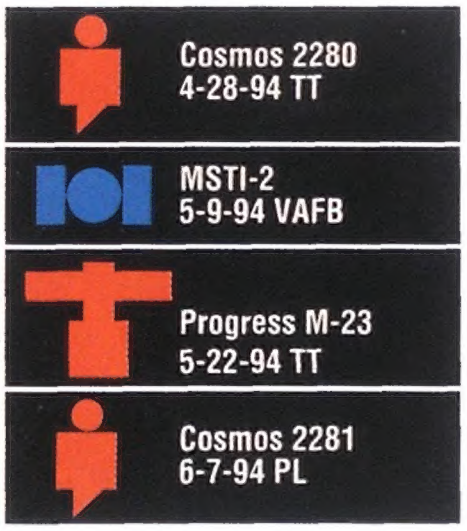
September 24
Calistoga Auto & Air Fair. Calistoga Gliderport, Calistoga, CA, (707) 942-6333.

"The Satellite Sky" Update/43

These regular updates to "The Satellite Sky" chart will enable readers to keep their charts up to date. Additions can be clipped and affixed to the chart at the appropriate altitude.

New launches

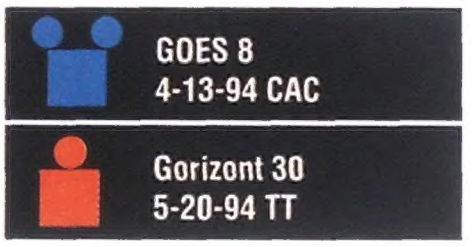
90 to 300 MILES



300 to 630 MILES

6,200 to 13,700 MILES

21,750 to 22,370 MILES



Deletions

90 to 300 MILES

Progress M-17
down 3-3-94

Inoperative but still in orbit

300 to 630 MILES

Cosmos 2180

21,750 to 22,370 MILES

Anik D-1
CS-2A
Fleetsatcom (launched on 1-18-80)
Fleetsatcom (launched on 10-31-80)
Galaxy 1
Gorizont 5
Gorizont 6
Morelos A
Raduga 10
Raduga 27
RCA Sat 4
RCA Satcom 6
SBS
Superbird A

DATA: SAUNDERS KRAMER

FORECAST

In the Wings...

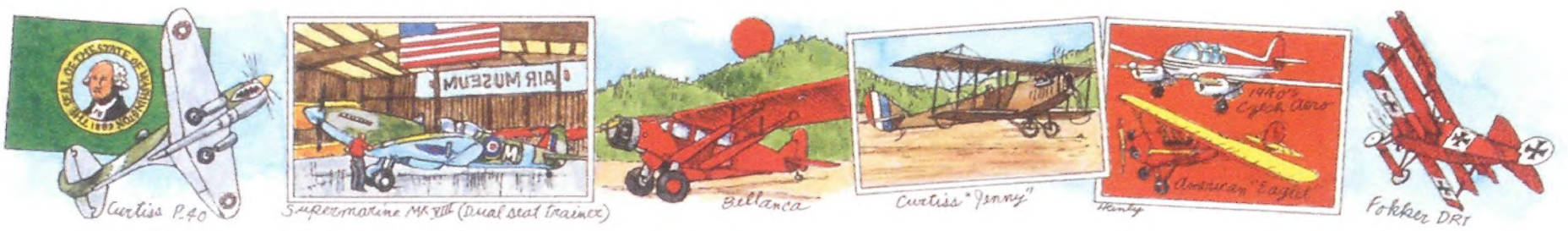
What's Up With the Ozone? For years we've been hearing alarming talk of man-made chemicals piercing a hole in the atmosphere's protective ozone layer. But now some scientists say that the ozone has always fluctuated over the years—and such changes are perfectly natural.

The Atmosphere: A Special Graphic Supplement. The what, where, and how of the layer of gases that makes life on Earth possible.

The Stearman. It didn't have the glamour of the P-51 Mustang or the P-38 Lightning, but the stout trainer still rouses the affections of thousands of World War II veterans—including a former president.

Prying Open the Skies. The question of who gets to control the world's air routes is a sticky one, involving money, power, and pride. Over the decades it has strained relations between nations that otherwise consider each other allies. Now that foreign airlines are buying their way into partnerships with troubled U.S. carriers, the old debate is acquiring a new urgency.

Spratt, Schmittle, & Co. After 90 years of experience, why haven't we solved such basic aeronautical problems as stall and turbulence? A few iconoclasts say the solution is easy: let the wings swivel and the rest of the airplane can stay level. A startup company based on that philosophy has caught the attention of some big names in aerodynamics.



JOHN HEINLY

Northwestern Exposure

There's a charming tale about how Lieutenant Oakley Kelly came to be the first commanding officer of Pearson Airfield. In 1923, Kelly and Lieutenant John Macready made the first non-stop airplane flight across the continental United States. After the historic trip, Kelly's commanding officer took him aside and said, "Lieutenant Kelly, you're a famous officer now, and as such you should be the commanding officer of an Army base. Pick out the one you want and I'll send you there." Kelly put his hand over his eyes and jabbed his finger at a map of the United States. When he opened his eyes, he saw he was destined for Vancouver, Washington, home of what had only recently been a U.S. Army parade grounds.

Today, the site is home to a small general aviation airport, Pearson Airpark, and the Pearson Air Museum, which offers an eclectic vision of the history of aviation, particularly in the Northwest. The museum charts how the field has evolved since 1905, when Lincoln Beachey, the first American to fly a loop, landed there after crossing the Columbia River in a one-man dirigible. Within five years, the Army was allowing aircraft to take off from the grounds.

During World War I, the Army opened a sawmill nearby to produce the Sitka spruce lumber needed to make warplanes, as well as hangars at the new field. After the war, the Army stationed the 321st Observation Squadron at the field. Flying Curtiss Jennys, the squadron searched for everything from forest fires to smugglers. In 1925 the Army named the field after Lieutenant Alexander Pearson Jr. of Vancouver, who had been killed the year before in an air race.

Though the region's flying history is not widely known, it's full of drama. One exhibit at the museum documents the first nonstop flight over the North Pole, made by three Russians in a gigantic ANT-25 in June 1937 (see "Soviets Blaze Sky Trail to Top of World," Dec. 1987/Jan. 1988). They landed at Pearson, but only because fog kept them from flying on to their intended destination, San Francisco. Nonetheless, the Vancouver newspaper boasted: "Russians Know Airports." Also shown are photographs of a few of the balloons the Japanese equipped with incendiary devices and lofted toward the U.S. west coast during

Pearson Air Museum, 1105 E. 5th St., Vancouver, WA 98661, (206) 694-7026. Open Wed. through Sun., noon to 5 p.m. Admission: $2 adults, $1 students; preschoolers free.

World War II. The American press refused to report on the balloon bombs in order to bolster the impression that the effort was wasted. (It *was* unsuccessful: of some 6,000 balloons sent, the only casualties were an Oregon woman and five children.)

One exhibit exemplifies the museum's commitment to dredging up the Northwest's aviation history, no matter how quirky. Titled "Aircraft of the Woods and Water," it shows pieces of a few of the hundreds of airplanes that have gone down in Lake Washington and the mountains of Washington and Oregon.

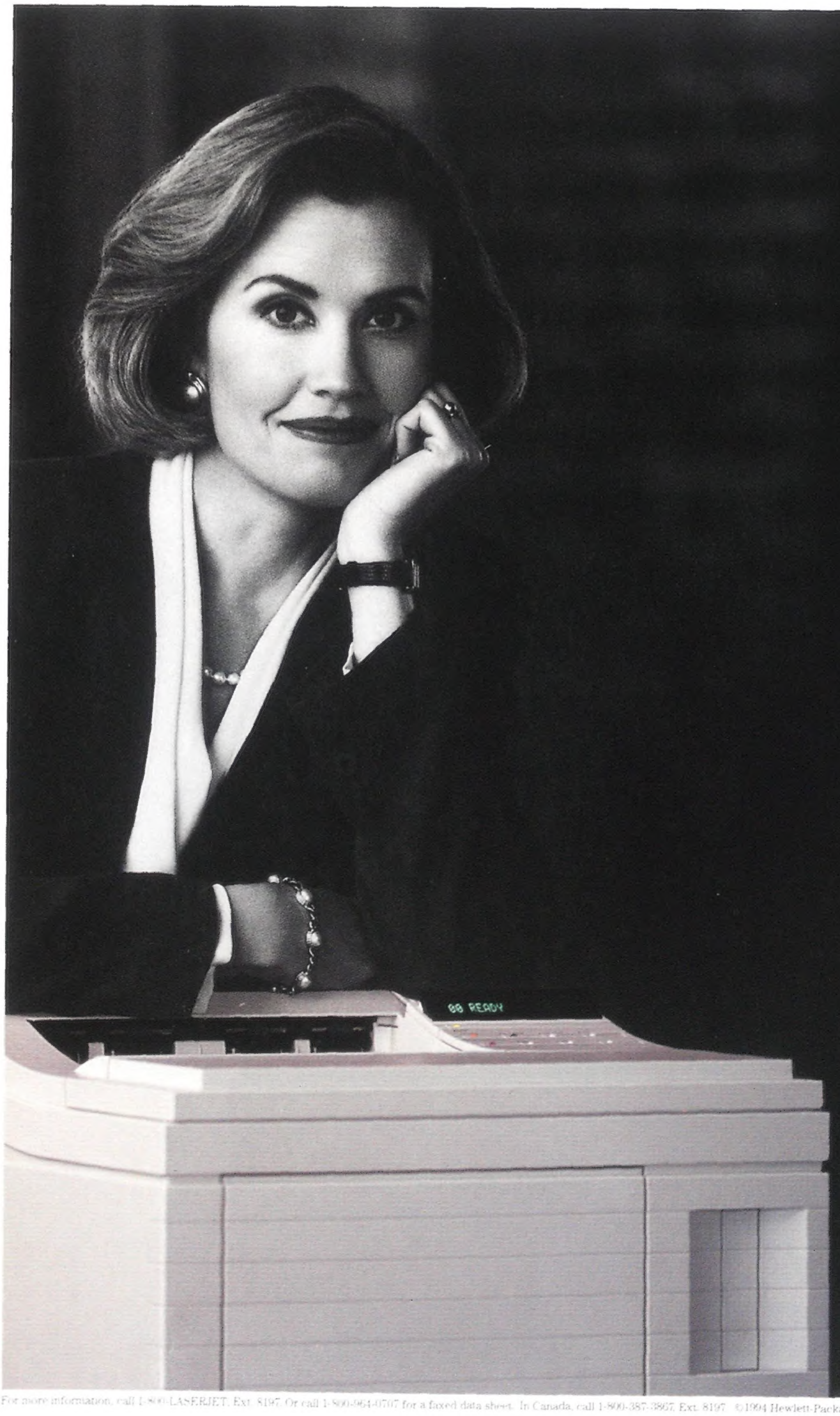
As far as intact aircraft go, the museum relies on both permanent and temporary loans from residents of Vancouver and other parts of the Northwest. (Visitors intent on seeing a particular airplane should call ahead to see if it will be there.) Neil Rose, a local manufacturing executive, loaned his Hawker Hurricane, which he had found up in Saskatchewan, Canada. The farmer who owned it was dragging the wings around his fields, using them to level the land. One Saturday, while Rose was talking to visitors about the history of the Hurricane, a man standing nearby quietly said, "I flew one of those in the Battle of Britain." Rose introduced the fellow, Les Burns of Vancouver, to the visitors, and Burns went on to tell them what it was like to fly against the Luftwaffe.

The museum has also displayed a Fokker triplane, a restored 1917 Curtiss Jenny, a replica of a 1932 Gee Bee, and such World War II craft as a Curtiss P-40, a beautifully restored Lockheed PV-2 Harpoon, and a T-6 trainer. In addition to airplanes, the museum exhibits the largest piece left from the explosion of the *Hindenburg*, Germany's famed dirigible. There's also the first prototype of the famed Ellsworth Equilibrator autopilot, which was invented by Vancouver resident Dighton G. Ellsworth and first used in 1911, in a Curtiss pusher flown from the airfield.

The buildings at Pearson are themselves artifacts, dating back to the years when they served the Air Corps. The museum members would like to restore the buildings, as well as rebuild a hangar that burned down years ago, in order to re-create the early Air Corps field. But the museum's plans are at odds with another effort at historic preservation. Today, part of the airport's land is owned by the city and part by the National Park Service, and the park service wants to use its portion to re-create Fort Vancouver, a trading post the Hudson Bay Company established in 1804. That undertaking would transform the present runways into potato fields. The museum's supporters have met with the regional branch of the park service and worked out a tentative compromise that would transform the entire site—the airfield, Fort Vancouver, and some historic Army housing—into a National Historic Reserve, where all could coexist.

It's too soon to tell if Congress will give the required approval. But the museum was born of adversity. In 1986 the city of Vancouver was ready to sell its portion of the land to the Portland Trailblazers basketball team. It was the passion of local aviation buffs that persuaded the city to preserve the historic airfield, enabling an air museum to open on the site. Today, it's the passion of the buffs that keeps Pearson Air Museum stocked with artifacts documenting the region's rich aviation history.

—Jim Anderson



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